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Mutual Understanding

When a man envisages assuming a new position in industry, he obviously makes as many inquiries as possible in order to satisfy himself as to the standing of the new employers. One works, the Midland Electric Manufacturing Company, Limited, of Birmingham, has anticipated this demand by issuing a booklet for presentation to each entrant into its employ. Herein are detailed the history of the firm; the terms of employment, wages and working hours; welfare and social activities, and some information of a general character. In an introduction two points are stressed. The first is the necessity for cleanliness as related to general hygiene and to its business aspect, because it favourably impresses potential customers as bearing upon quality. The second point is the function of the Personnel Department, which exists to advise the staff about such matters as evening classes and insurance.

The terms of employment are well set out, and the absence of negatives is praiseworthy. Some similar books we have seen are vitiated by an attempt to be intimate by the introduction of a number of "Don'ts." The number of rules involving dismissal is commendably short, nearly half of them being indictable offences at law, whilst the balance are bad for the individual or liable to cause accidents.

Rules governing the payment of wages and working hours are, as they need to be, carefully set out; for they are nowadays interlocking with holidays with pay and pension schemes.

Under the heading of "welfare and social activities" it is assumed that the benefits of safety-first are appreciated as obviously they should be, and here an addition is made to rules for instant dismissal. Where a man breaks "safety-first" rules by neglecting to comply with the provisions made for the general good of the staff, he is liable to have action taken against him. Full details are given as to medical treatments afforded as a result of mass hospital subscriptions.

We do not suggest that every firm should go to the length of printing an illustrated pamphlet, but whoever is responsible for engaging a new employee should outline, preferably by handing over typewritten sheets, the whole of the conditions existing at the works, and not leave the new man to learn of them casually. Especially should the regulations about timekeeping be pointed out, as no two firms have the same regulations and, moreover, they are more often custom of the trade applying differently in the various shops than fixed rules. There has recently been a recognition, since nowadays the operatives do not live so near to their works as formerly, that allowance has to be made for breakdowns in transport and other factors over which the workpeople have no control. The rule covering lateness in the booklet we have referred to seems equitable and reads: "Employees are not allowed to work for any half-day on which they arrive after the time appointed for starting. To cover emergencies, this rule will not be enforced unless they have been late on four previous occasions. (For those living more than a mile from the works this number will be increased to seven.) It will then continue to operate until three months have elapsed without being late." This is typical of the information which should be divulged, and of equal importance is a knowledge of the attitude of the firm towards service with the Territorial Army or other national activity. Actually the complete disclosure of all the conditions surrounding employment at the time of engagement tends to save money by the elimination of later discussions. Quite often a man only stays an odd week or so because he has been inadequately apprised of the conditions obtaining in a works, and such employment is a cost to the employers and unsatisfactory for the man. Any firm envisaging the issue of an employment book must obviously precede such an action by the creation of a works committee, otherwise there is a likelihood of misunderstanding amongst the existing staff. The social activities of a works need to be built up very gradually, otherwise there is a danger that during a lean period the management may find that it has "bitten off more than it can comfortably chew." Especially does this apply to the granting of shares, and some pension schemes. When employment decreases to 20 or 25 per cent. normal, some schemes become top-heavy, and have been known during the last slump to occupy more of the attention of the directorate than the general conduct of the business. Thus it is wise when engaging new men to point out that many of the benefits of the pension and other schemes can be obtained economically by individual effort rather than interlocking it with employment. Again, where a full range of social activities is not undertaken, it is desirable to indicate that the local institutes or religious bodies provide recreational and sporting activities. By so doing, a modest concern can compete with the largest companies in the recruitment of suitable labour. To-day, the brief instruction "Start at 8 o'clock next Monday, and ask for Mr. Jones, the foreman," is entirely inadequate.

SCOTLAND.—Although there is little indication of any increase in the demand for Scottish iron, for New York on January 18. Somewhat naturally, national emergency.

Precarious Copper Position

BY "ONLOOKER."

The publication of last December's statistics showing an increase of 32,000 short tons in world stocks of refined copper came as something of a shock to the market. Even more disturbing was the news that apparent consumption in the United States had slipped back to below 40,000 tons. Deliveries during November were not good, and it was hoped that December would show an improvement, but instead of that the trend proved to be in the opposite direction. It may be, of course, that American consumers were desirous of getting their copper holding down before the year-end, and if that surmise be correct then one may expect to see an improvement in the January returns when they appear, but sales on the domestic market in the States during the last quarter of 1938, and indeed in the early days of this year, were not at all satisfactory. Actually, opinion about the outlook in America has rather veered round, and people are not so optimistic as they were, their views being coloured to some extent by the fact that developments on Wall Street are not particularly satisfactory. True, Stock Exchange forecasts are not always correct, but rightly or wrongly the metal trade looks to the prevailing sentiment on the New York market to give a lead as to the future, and there is no gainsaying that the strong upward movement hoped for on Wall Street has not developed.

For about three months primary producers in the States have held their price at 11¼ cents delivered Connecticut Valley, in spite of the fact that the world price of copper, as determined by the London Metal Exchange quotation, was a long way below this parity. Moreover, in America Custom smelters and secondhands have been taking all the business available, so much so that some weeks ago certain of the largest primary producers in the States made a cut in production in order to cope with the situation. The statistical situation in America is not developing at all satisfactorily, and it has been suggested that an upward movement in London would go a long way towards keeping the New York price stable, but the chances of any upswing here would appear to depend upon a strong buying movement developing across the Atlantic, so that the markets are really waiting each for the other to give a lead. A rather hopeless state of affairs! At the present time, however, the international political situation is not conducive to a resumption of long-term buying.

Judging from the December figures, it would seem that the copper position is in equilibrium outside the United States, but that affairs are ill-balanced inside. Moreover, as from January 1 extra-American production has been brought down to 100 per cent. of standard tonnages, and this should serve to prevent any unwieldy increase in stocks, but the volume of European buying during 1939 remains problematical. It is well known that many governments have accumulated very large stocks of copper, and although in some directions it may well be that reserves have still to be collected, there is already something of a drop in the volume of buying. In these circumstances one cannot be very optimistic about the future of the copper price, and it is certainly not easy to imagine the American consumers taking a bullish view of the future; their move would appear to lie in playing a waiting game until such time as the producers have to give way. If copper is to stage an improvement of any magnitude then in the first place the U.S. quotation must come down to the level of the world price as represented by the London valuation.

Patching the Cupola

BY "DAUB."

To obtain the best results from a cupola lining, as well as the most efficient working of the furnace, it is necessary to patch the melting zone to a standard diameter after each blow. The life of a cupola lining depends largely on the patching, and if this is of an inferior quality or indifferently applied, the best results cannot be obtained. The patching material should be of a similar composition to the bricks forming the lining, so as not to create any chemical reactions which may result in the lowering of the melting point and cause softening at a lower temperature, and thus bring the whole patch and a portion of the brickwork down as slag.

Even if the patching material is of the correct composition and consistency, the patch may come down if not properly applied. Especially is this true if the patch is thin and the slag on the face of the brickwork has not been removed. To patch a cupola most effectively, it is necessary to remove the slag which has glazed over the lining, and so make a joint between the refractories, and minimise the tendency for the slag behind the patch to melt, and thus throw the lining off from the brickwork. Difficulty is sometimes experienced by furnacemen in removing this slag during the fettling operations, because of its hardness, which often causes the tools used to rebound without accomplishing the removal of the slag. Foundries with a supply of compressed air laid on will find the use of a pneumatic chipping hammer of great advantage in the more effective fettling of their cupolas. The hammer, fitted with a cross bit which reciprocates, but does not revolve, can be used quite easily, and when worked over the face of the lining, removes the slag and penetrates into the brickwork, enabling the patch to be more satisfactorily applied. The latter, if of the correct composition and consistency and pressed in tightly with the clenched fist, then well vented and dried with a slow fire, should give satisfactory service.

Notes from the Branches

Lincolnshire Section.—A few years ago this Section was in a poor way, the number at meetings being rarely over ten. During the past two years the number of members has almost doubled, and more lively interest is being taken. The attendance has increased to between 25 and 35, journeys of 20 and even 40 miles being taken to attend. This is very gratifying to the officers during recent years, whose efforts have been so well rewarded.

Dr. A. B. Everest gave his Paper, "Thirty Years' Progress in Cast Iron," at Lincoln on January 23, Mr. G. L. Harbach being in the chair. The meeting was well attended by 31 members and visitors. The reading of the Paper was greatly appreciated and led to an interesting discussion. Points relating to foundry problems, methods and uses of alloy additions, corrosion resistance and cavitation of ships' propellers were all dealt with, those taking part being Mr. Gladwell, Mr. Mather, Mr. Phillips, Mr. Palethorpe and Mr. Booth. From the reports since received, and the informal discussions after the meeting closed, there is no doubt that the Paper proved extremely interesting to all, and the vote of thanks to Dr. Everest, proposed by Mr. Dunleavy and seconded by Mr. Carrott, was acclaimed with enthusiasm.

THE WELSH INDUSTRIES FAIR has had to be postponed this year because now that Greyfriars Hall no longer exists Cardiff has no large building available in which it can be housed.

Random Shots

A correspondent, evidently suffering under the delusion that foundrymen must positively like tackling difficult problems, even when not directly connected with costing, has sent in the following "brain duster."

A train is operated by three men, Smith, Robinson, and Jones, who are fireman, engineer, and guard, but not respectively. As passengers on the train are three metallurgical gentlemen, Mr. Smith, Mr. Robinson and Mr. Jones. Consider the following facts:—

(1) Mr. Robinson lives in Birmingham.

(2) The guard lives halfway between London and Birmingham.

(3) Mr. Jones earns exactly £400 annually.

(4) Smith beat the fireman at shove-halfpenny.

(5) The guard's nearest neighbour, one of the passengers, earns exactly three times as much as the guard who earns £200 a year.

(6) The passenger whose name is the same as the guard's lives in London.

* * *

Who is the engineer? Readers must be able to explain fully their deductions. As far as "Marksman" is concerned the answer is a lemon.

* * *

Much is talked of these days of the inability of university-trained young men to "get down to it" in the works, the relationship between theory and practice being far too remote, and indeed it was only the other day that a technical-school student confessed that until quite recently he had always thought that a chargehand was the man who filled up the cupola!

* * *

A good foundry story, the truth of which can be vouched for, is of an apprentice who, having been using blacking during the morning, went home for dinner without washing. He arrived back at work in the afternoon with hands and arms just as black as when he left the foundry. The foreman commented on this fact, asking if he really had not washed his hands before dinner.

"There's no need to," replied the astonished lad, "you see, we use knives and forks in our 'ouse."

* * *

According to the brochure issued for the International Foundry Congress, to be held in London this year, one may eat noddles in Soho. Is this suggested as suitable fare for hard-headed business men, or intended as a treat for noodles?

* * *

One New Year's morning a man was walking down Regent Street, accompanied by two crocodiles. Arriving at one American bar, he told them to stop outside whilst he went in for a couple, which they did only after much protestation. Crossing the road, he came to a second bar. Once again he prepared to leave the crocodiles outside, but this time the protestations were even louder. This call was not a long one and they thought they would at last be able to finish the walk in peace. Yet a third time our man requested them to wait outside.

"Look here," they said, very angry, "we've had about enough of this continual hanging about."

"You had better be quiet," replied their master. "You ought to consider yourselves jolly lucky to be here, for if I'd taken a couple of aspirins this morning I shouldn't have brought you out at all!"

"MARKSMAN."

to reduce the wear of liner, piston and rings

Practice in Mechanical Testing*

MACHINES AVAILABLE AND TEST-HOUSE EQUIPMENT

By V. E. GREEN

The beam tensile-testing machine in its best and simplest form is of the single-lever type, having two knife edges with the straining gear hydraulically or screw-and-nut operated. With an electrically-operated straining gear, foundations are cheaper, and the unit is more self-contained and water leakage is absent. The chief advantage which the author has found with the electrically-driven machine of the screw-and-nut type is that the load can be made to remain constant, which is a useful point when using extensometer measuring apparatus or when calibrating the machine with dead weights or a "calibration box." The single-lever beam machine is rather bulky, but very accurate. The test house has to be large and provided with overhead lifting tackle for overhauling and checking purposes. The later multi-beam machines and hydraulic-ram dial-indicating types, however, take up little room in a test house, and in the author's opinion should eventually cost much less to install than the older beam type.

Those monuments of engineering, the Buckton machine, are still doing good routine testing work all over the country, and are chiefly of the single-lever ram-operated type, the jockey weight in many cases also being moved hydraulically along the beam. The Dennison machines which the author has seen have been rather small capacity machines, while the Olsen is a multi-lever screw-and-nut operated type, provided with gearing and clutches to obtain variable straining speeds and a quick resetting return. Lastly, the Rhiel type is rather similar to the Olsen, and in common with that make is generally provided with direct-reading indications of the load. Some form of poise-propelling control and reasonably good stress-strain recorders for ductile materials are provided.

One of the oldest and perhaps still the best method of recording the load is by using a moving poise along the beam. When properly operated, the load on the specimen can be easily read and checked by any observer, and the test cannot very well proceed incorrectly. With the hydraulic pendulum, ram-operated dial or pressure gauge readings, it is possible to break a test piece without correctly observing the load, owing to the more delicate mechanism involved going wrong. Direct pressure gauge readings of loads require constant checking and calibration, and should only be used for approximate testing work. The vertical beam type of tensile-testing machine can easily be adapted for other tests, such as torsion, shear tests requiring special grips, compression and bending tests when a suitable cross-over cradle is suspended from the top shackle.

Horizontal Machines

So far, no mention has been made of the horizontal type of tensile-testing machine. It is rather obvious, however, for general tension or compression tests, that the vertical type produces a simpler design from a knife-edge point of view, and most of the extensometers now produced are more suitable for a vertical test piece. With long chains, ropes or struts, the horizontal design is suitable and is most easily accommodated in any ordinary building.

Many ingenious devices have appeared for operating grips of the wedge or split collet type used for tension tests. For general work, the plain wedge toothed grip directly hand operated is quite sufficient, and, with parallel-ended test pieces of adequate length, gives satisfactory results on most materials. If shouldered pieces are used, less length may be required, but preparation costs more, and extra time can be taken in fixing. Axial-loading grips are often called for in specifications, but many designs are too cumbersome. If the testing machine is well designed and care is taken to grip the piece intelligently, accurate results can be obtained by an intelligent operator. Inaccuracy of test results can be brought about by means other than those due to gripping. With "slippery" materials like the manganese and aluminium bronzes, carefully screwed-end test pieces have been found by the author to be very satisfactory.

The "rate of loading" is often mentioned by testing engineers, and is a subject brought up by people when discussing differing results on material tested in different test houses. The author has tried the effect of various commercial rates of loading on materials under tension, and is of the opinion that the variation of test results is chiefly due to the difficulties of reading the load on the specimens, that is, either the poise weight moves too quickly along the beam or the pointer too quickly round the dial for a precise reading at the moment of fracture of the test piece. This feature is a question both of machine design and of skill of the machine operator, and is perhaps a good point for the dial-type hydraulic machine with less inertia of moving parts.

Use of Extensometers

The use of commercial extensometers has advanced rapidly to the front during the past year or so, due to the proof-stress clause in various modern specifications. The established Ewing instrument is still considered the standard one for the usual 0.564 or 0.798 in. dia. test piece. It is not, however, suitable for thin-strip materials, and for such purposes a clock-dial type of instrument is now used. The general make of dial instrument is very suitable when, among other points, the construction is such that applied to the test piece no bending is produced when freely hung. The Lindley extensometer now produced for a 2-in. gauge length appears to be an excellent instrument in which all doubtful points in past designs have been put right. Measurements of length change on the specimen of 1/20,000 in. can be made up to a total extension of 0.1 in. The Huggenberger extensometer is of the lever pointer type, and gives excellent results on thin strip or round-bar test pieces, and it is easily applied to the specimen. The normal range of the instrument is from 1/10,000 in. to 5/1,000 in., but with the pointer reset test-piece elongations up to 1/10 in. can be satisfactorily accommodated. In dealing with proof-stress determinations, the author believes it is best to plot the curve fully and not to rely on the three point or other shorter method of obtaining the proof stress.

Fortunately for the engineer designer, the results of hardness tests as carried out at present bear a close relationship to the tensile strengths of the same materials. Only those in charge of testing departments handling production work, fully realise the usefulness of that. Due to this relationship testing can be carried out on what may be termed 100 per cent. basis (*i.e.*, physical tests on a test-piece and hardness tests on the articles) and is the system adopted by the A.I.D. for many aircraft components. So far as the Brinell machine is concerned, by whatever means the loading is operated, in all cases the impression produced has to be read with a separate microscope and scale and a hardness numeral read from a chart. In a later machine of Continental design, the image of the impression is projected in a magnified form on to a ground-glass screen, where it can be very easily read on a steel rule. Attachments are fitted so that it can be quickly noticed if the impression is smaller or larger than the correct figure for the particular article tested. The machine referred to can almost be automatically operated using electric power, and accurate work at reduced speed of testing can be obtained. The necessity of increased speed of testing was one of the chief reasons for the introduction of the direct-reading hardness-test machine, such as the "Rockwell" apparatus and similar types. With one of these machines, over a hundred of small stampings or pressings can be tested per hour by a good operator. The scale reading is the hardness numeral for the particular load or indentor used and no microscope or chart is required. It is, however, very important to choose a load and ball size suitable for the material and its thickness, otherwise incorrect hardness values are easily obtained. The author believes that observers' ideas on the subject of hardness testing require collection and then to incorporate the summary in a testing specification which should be in every design office. The Vickers diamond hardness-testing machine, in the author's opinion, is an excellent example of a precision-testing machine, and is one of the first pieces of physical apparatus he would install in a general testing laboratory. The output from the machine with a few special jigs and a skilled operator can amount to about 80 per hr.

The Shore scleroscope is a useful adjunct in a general test house where quite a number of investigations are helped by its use. For large articles, such as mill rolls, the instrument can be taken to the job instead of *vice versa* and reliable hardness results are obtained.

Calibration

The calibration of hardness-testing machines presents many difficulties, and the author has not yet heard of a "standard hard" housed at the N.P.L. Bearing in mind the enormous capital expenditure on machine tools and cutting appliances, on case-hardening and nitriding furnaces and of the utmost importance of hardness, it appears necessary that some series of standardised hardness test-blocks should be issued by a competent authority at a commercial rate. Such test-blocks could be stamped like weights. The Izod 120 ft.-lb. type of impact-testing machine is too well known to require description. Small test-pieces have been tried, but generally speaking there is no standard comparative figure to bring those results in line with the usual test-pieces, and the author prefers to rely upon a plain saw-cut-notch fractured bar and to judge from the examination of the fracture whether the standard impact figure would be, say, lower than 30 ft.-lbs. It is obvious that an impact figure is a useful indication of the internal character of the steel, but unfortunately the actual numerical results obtained do not directly aid the designer of machine parts in the same way as a tensile or torsion test does.

The range of allowable stress under an alternately-stressed piece of material is an important characteristic when the suitability of that material is being discussed in a design office. There are a number of machines upon the market, suitable for obtaining those figures, but unfortunately with all machines the cost of testing is very large.

NEWTON CHAMBERS & COMPANY, LIMITED, ironmasters, colliery owners and chemical manufacturers, have placed £300,000 4½ per cent. registered redeemable notes, 1948. The proceeds of the issue will be applied partly in the purchase of freehold land and the installation of plant for the manufacture of excavators under licence from the Harnischfeger Corporation, of Milwaukee, U.S.A. The issue will provide also for the working capital necessary.

E

* From a Paper read before a meeting of the Midland Metallurgical Societies in Birmingham last week.

Wear in Powdered-Fuel Diesel Engines

COMBINATIONS OF METALS INVESTIGATED

The Report of the Director of Fuel Research issued with that of the Fuel Research Board contains a section giving the results of experiments in connection with the powdered-fuel Diesel engine.

It was mentioned in the last Report that experimental work had been begun at the Fuel Research Station to determine whether the high rates of wear encountered in coal-dust Diesel engines could be reduced to practicable proportions by suitable choice of materials for the liner, piston and rings. These high rates of wear are due to the abrasive action of the ash present in the coal. During the expansion and exhaust strokes in the engine cycle, part of the ash and possibly carbonised or unburnt particles of coal are brought into contact with, and adhere to, the film of lubricant on the cylinder walls, thus forming an abrasive paste which causes rapid wear of the liner, piston and rings.

The method adopted in these experiments is to inject coal ash at a constant rate into the carburettor intake of a single-cylinder petrol engine running on petrol under controlled conditions of load, speed, etc., and to measure the liner, piston and ring wear after suitable intervals of time. Some 27 combinations of materials for liner, piston and rings have now been tested in this manner. The influence of the rate of ash feed, and the fineness and type of ash are also being investigated. The results of this investigation have been such as to suggest that the wear can be reduced to reasonable proportions by suitable choice of materials. It was then decided to proceed with the purchase of a second-hand Diesel engine which has now been installed with a view to converting it to use powdered coal.

TABLE I.—*Influence of Liner Hardness upon Wear of Liner, Piston, and Rings.*

Liner.	Hardness. V.P.H. value.	Maximum liner wear. 1/1,000 in. per hr.	Top ring wear. Grms. per hr.	Maximum piston wear. 1/1,000 in. per hr.
Aluminium alloys	60–145	10.0–11.45	2.46–4.96	0–8·4
Unhardened cast irons ..	200–240	2.1–3.5	1.83–2.60	3.25–6.3
Hardened cast irons	500	1.20	0.90	2.4
Nitrided steel and cast irons..	950–1,000	0.46–0.61	0.16–0.61	0.31–1.41
Chromium-plated cast irons..	Approx. 1,000	0.046–0.112	0.15–0.70	0.20–1.55

Wear Tests

Three identical engines have been used for these tests. Each is a J.A.P. overhead valve, water-cooled single-cylinder unit of 3¾ in. bore and stroke. The Amal carburettor of each engine has been fitted with an extended intake tube of Venturi cross section into which the ash is drawn by engine suction. The ash is fed from closed hoppers to the intake tubes by means of small Redler-type conveyors of Fuel Research Station design, each conveyor being independently driven by chains and sprockets from a common shaft which is in turn driven by an electric motor.

For comparing wear rates of different combinations of materials the coal ash used as standard throughout was collected from the tail flues of a Lancashire boiler fired by pulverised coal. A quantity sufficient to last through the entire investigation was collected prior to the tests. This ash contains about 20 per cent. of carbon and about 80 per cent. passes through a 240-mesh B.S. sieve. The rate of ash injection adopted (52 grms. per hr.) corresponds approximately to the amount of ash which would be present if the engines were run on the Diesel cycle at a B.M.E.P. of 100 lbs. per sq. in. with coal containing 2 per cent. of ash.

A wide range of materials has been tried for the liner. It includes aluminium alloys, unhardened cast irons, hardened and tempered cast irons, nitrided cast iron, nitrided steel, anodised aluminium and chromium-plated cast irons. The majority of tests have been made with ordinary cast-iron pistons and rings, but tests have also been made with specially-tough, close-grained, cast-iron pistons and rings. The effect of anodising, tinning, nitriding and chromium plating these components has also been investigated.

The tests so far made all show certain common wear characteristics. Thus liner wear is almost entirely confined to the ring track and reaches a maximum at a point slightly below the top of the ring track. This is illustrated in Fig. 1. Piston wear is confined largely to the thrust faces; it is greatest at the top or first ring land and decreases progressively towards the skirt. The ring wear is always most severe in the top ring and is usually least in the bottom ring. A typical series of ring-wear measurements is shown in Fig. 2.

The results of the tests already made indicate that liner hardness is a vital factor in determining the wear of liner, piston and rings. This is illustrated in Table I, in which the results are grouped in order of liner hardness.

It will be seen that, in general, the harder the liner the smaller is the rate of wear of liner, piston and rings. Thus, the lowest rates of wear of all three components have been obtained with chromium-plated and nitrided liners and the highest rates with aluminium and unhardened cast-iron liners. The former show considerable advantage over ordinary cast iron. It has also been found that the substitution of hardened rings for plain cast-iron rings, in conjunction with a hard liner, usually reduces the rate of ring wear at the expense of a somewhat increased rate of liner wear.

The best results to date have been obtained when using certain types of chromium-plated liner in conjunction with ordinary cast-iron piston and rings. With these combinations the rate of liner wear is approximately one-seventieth, the top ring wear one-sixteenth and the piston wear about one-thirtieth of that obtained with ordinary cast-iron liner, piston and rings. It will be seen from Table I that, in spite of this reduction, the actual rates of wear with such a combination are still high, but it is believed that the abrasive conditions to which the materials are subjected in these tests are more severe than those encountered in actual powdered-coal engines. It is considered that the rates of wear likely to be encountered in practice, with suitable coal, are probably of the order of one-tenth of those found in these tests when using similar combinations of materials.

The influence which the fineness of the ash exerts upon wear rates is shown by the results of experiments given in Table II.

These results were obtained with ashes prepared from two samples of the same coal (a Northumberland steam coal) ground to 58 and 92 per cent. respectively through a 240-mesh B.S. sieve. An ordinary cast-iron liner, piston and rings were used in each case. It will be seen that the effect of increasing the fineness of the original powdered coal by the amount stated is to reduce the wear of liner, piston and rings by about 25 per cent. The finer of the two samples of ash probably corresponds fairly closely, as regards fineness, to the ash actually liberated in the cylinder of a powdered-coal engine and gives rates of wear approximately one-half of that obtained with ash used in the main series of experiments.

TABLE II.—*Influence of Fineness of Ash upon Wear of Liner, Piston and Rings.*

Fineness of original powdered coal.	Maximum liner wear 1/1,000 in. per hr.	Top ring wear grm. per hr.	Maximum piston wear 1/1,000 in. per hr.
58 per cent. through 240 B.S. sieve ..	2.02	1.26	1.57
92 per cent. through 240 B.S. sieve ..	1.54	0.93	1.17

Comparative tests have also been made of the abrasive action of ashes from the bright and the dull fractions of a South Yorkshire medium caking coal. These ashes were prepared from coal samples ground to a fineness of 81 per cent. through a 240-mesh B.S. sieve, and were used in conjunction with ordinary cast-iron liners, pistons and rings. The results of the tests are given in Table III.

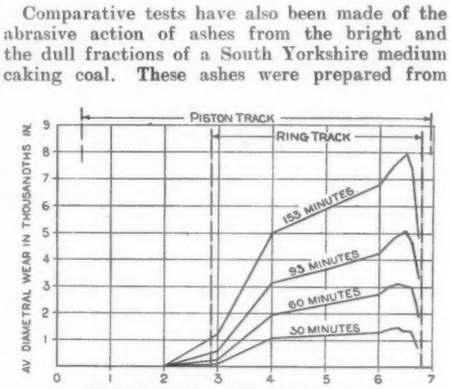

FIG. 1.—CYLINDER WEAR WITH CAST-IRON CYLINDER, PISTON AND RINGS.

TABLE III.—*Comparative Wear Figures with Bright and Dull Fractions of a South Yorkshire Medium Caking Coal.*

Fraction of coal from which ash was prepared	Maximum liner wear 1/1,000 in. per hr.	Top ring wear grm. per hr.	Maximum piston wear 1/1,000 in. per hr.
Brights	0.74	0.514	0.67
Dulls	0.52	1.173	1.97

It will be observed that the wear rates with the dull fraction of this coal are more than double those with the bright fractions.

The engine now being installed for conversion to powdered coal is a two-cylinder Diesel engine made by Mirrlees, Bickerton & Day. It has a bore of 12 in., a stroke of 18¼ in., and is designed to run at 230 r.p.m. Preparations are now in hand for converting one cylinder to the use of powdered coal.

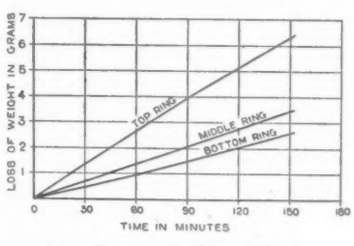

FIG. 2.—PISTON-RING WEAR.

Machine-Moulding

DISCUSSION AT LEICESTER

An enlightening discussion followed the presentation of Mr. B. Gale's Paper, "Some Notes on Machine-Moulding," to the East Midlands Branch of the Institute of British Foundrymen at Leicester. The Paper was published in full in the JOURNAL last week.

The BRANCH-PRESIDENT (Mr. R. Spriggs), opening the discussion, said he was particularly interested in the emphasis that Mr. Gale had placed on the necessity for thorough planning and preparation before commencing manufacture. He was also glad to hear from a foundryman a definite opinion on the much discussed relationship between the foundry and the designer; he agreed that the designer could not be expected to be an expert in foundry matters. Referring to the point raised on the use of support bands in flask moulding, he recalled that the members had recently visited a Birmingham works where flask moulds were made without the use of bands. This firm, he said, had found bands to be a nuisance in conjunction with their mechanised scheme and had taken steps to produce the moulds without their use.

Changing Conditions

MR. R. H. BUCKLAND did not agree that foundrymen never offered suggestions to designers. The trouble was that the jobs were rushed into the foundry and the buyer required his estimate so quickly that the foundryman did not have sufficient time to study the job or to make suggestions. Another factor that influenced this matter greatly was the number required for a particular job. Conditions were certainly different to-day from those of a few years ago. At one time buyers would intimate their requirements for a season, so that the foundry could make a definite decision on the type of plant required; nowadays they would only state their number for a month, and the foundry did not know whether a wood plant would be suitable or whether the job was worth a metal pattern. Mr. Gale had not mentioned the Sandslinger as a moulding machine; was this an oversight?

He agreed with the author's remarks on pattern compounds and the corrosion of aluminium inserts. There were a number of compounds on the market, and his own experience in every case was that a kind of salt formed after a few months' use. He believed, however, that an aluminium alloy had been made that would combat this corrosion, and he would like information on that mixture if possible.

MR. GALE said that the opinion he had put forward was the general attitude of foundrymen towards designers. He had heard that attitude expressed many times, and for some years he had been of the same opinion. However, a few years ago it became his job to visit the users of the castings, interview the engineers and the designers, see the castings in the course of machining, and take up any complaints and troubles; it was also his job to get agreement to modifications to design. This experience had given him a different opinion. He had seen the other man's point of view and he had found that, in the majority of cases, the engineer and designer were sympathetic, and if asked for alteration they usually acceded. He did not agree with Mr. Buckland that the foundry did not have time to study the job on account of the buyer rushing the job through; the foundry should not be "run" by the buyer. It had not been an oversight that Sandslingers had not been mentioned. He had purposely confined the Paper to the specific machines on which he had personal experience. He could not help Mr. Buckland in the mixture of aluminium to prevent corrosion; he would like such information himself, as the removal of the bugbear of corrosion would greatly assist the foundry and patternshop.

Mr. Gale agreed that, in certain classes of work, such as light electrical castings, bands would not be necessary in flask moulding, but in the case of heavy castings it was different. It would be disastrous to attempt to make, say, a flywheel casting weighing 50 lbs. in a flask 13 in. square, unless bands were used to support the mould.

Box Parts

MR. G. SMITH referred to the author's remarks on cast-iron box parts, and said that, in his experience, he had found cast-iron boxes to warp under the pressure of power machines. Would it not be cheaper to have plain drilled holes in the box lugs, and to scrap the boxes when the pin holes were worn, instead of having renewable brass bushes?

MR. GALE said it was a much cheaper proposition to renew the bushes. The trouble with plain drilled holes was that they so quickly became enlarged, due to wear and rusting, and when castings had to be made to very fine limits of mismatch this was an important matter. He had not had any trouble with cast-iron boxes warping; they kept their shape until broken.

Tolerances on Box Pins

MR. F. G. BUTTERS, referring to the tolerance of 0.002 in. on box pins given by Mr. Gale, said it was impossible to work to thousandths of an inch in a foundry. The tolerance mentioned could not be worked. It would be impossible to lower a mould so accurately by hand on to the bottom half-mould.

MR. GALE assured Mr. Butters that they did work to such a fine limit on box pins; but he thought that Mr. Butters had not quite correctly interpreted the Paper. The tolerance of 0.002 to 0.003 in. was given for the pins fixed in the pattern-plate, and the lift from those pins was operated mechanically by the machine. In the case of mould assembly pins he had given a larger tolerance of 0.006 to 0.007 in.

MR. BUTTERS said he still thought it was not a practical proposition.

MR. H. J. BECK said he had over 10,000 steel boxes in his foundry. The standard practice of his firm was to drill the pin holes in the boxes to 0.005-in. clearance. He was interested in the corrosion of aluminium in contact with stone compound; there must be a mixture to avoid that corrosion, as he had recently broken up a lay-out with aluminium in stone compound, and there was no trace of corrosion.

MR. GALE gave an instance of a pattern plant of a square box-shaped cover. A few months after the plant was made he was called to examine it, and found the pattern to be a mass of the salt-like corrosion. The expansion of the stone had been so severe that the aluminium had been forced apart to show a crack sufficient to pass a 0.02-in. feeler. A week later, that crack had opened to $\frac{1}{8}$ in., and that rather expensive pattern-plant had to be scrapped and remade.

MR. B. S. MORGAN recommended that the aluminium for pattern work be as pure as possible to overcome the corrosion troubles. He knew of only one definite method to prevent corrosion, and that was to coat the aluminium with an electrolytic deposit, which would most probably be too costly for pattern work. Referring to the remark on types of machines on which to make a job, he said he would never consider using sprigs and lifters to lift cods on an upright machine. He would put such jobs on a roll-over machine, as the time of inserting sprigs and lifters would be considerable.

Working Level Too High

MR. H. BUNTING said that the author had practically covered the whole field appertaining to foundry practice; but he would have liked Mr. Gale to have given some of the disadvantages of the various machines. Many machines were too high from floor level to give advantageous working. They were satisfactory if the sand was fed from a hopper, but when it had to be lifted by shovel from the floor, height was important. As to the remarks upon the designer and the foundryman, he thought that Mr. Gale had been too severe on the foundryman. The repetition foundry might have an opportunity of getting alterations, but in the majority of cases all the foundry received was the pattern, to which they had to work. They were not asked or consulted as to how the pattern should be made, but if they were called in by the designer or the patternmaker, many pounds and wasters could be saved by consultation. With aluminium patterns, he had found a mixture containing 10 per cent. of iron to be most advantageous in the prevention of corrosion.

MR. W. VICKERSTAFF said that one aspect of machine-moulding that could not be overlooked was the human factor. It was one thing to say a machine was capable of producing 50 or 100 moulds per hour, but it was another matter to get the man who could stand up to the machine and make that number of moulds. Was it possible to get labour to work the machines?

MR. GALE replied that he had had no difficulty in finding machine operatives. The general idea of the introduction of the machine was to take unnecessary labour off the man.

Mechanisation and Fatigue

MR. SPRIGGS said he did not think the fatigue on high-speed machines was as much as on floor moulding. On mechanised plants he had seen one hundred moulds per hour produced day by day without excessive fatigue of the man.

MR. T. GOODWIN said they seemed to be wandering from the subject of machine-moulding to that of the human element. Any type of machine could only work as fast as the man allowed it to do so, and when the man stopped, the machine had to stop. He did not altogether agree with Mr. Gale's remarks as to the designer. Sometimes it was very difficult to induce the designer to alter his job. Repetition foundries had a better chance of dealing with the job than the ordinary foundry. Very often jobbing work was so urgent that there was no time to make alterations to design. Tolerances on box pins obviously depended upon the class of work; the figures given by Mr. Gale would be satisfactory on some jobs, but could not be worked on others.

MR. J. F. MEASURES agreed with Mr. Gale on the question of pin tolerance. It was his practice to start with pins 0.003 in. tolerance, and when they had worn to 0.01 in., they were scrapped. He was surprised that no mention had been made of mounting patterns on wood boards for machine moulding.

MR. GALE said that he did not like wood boards for pattern-plates. He supposed they could be used for small-quantity production, but there was too much risk of warping and distortion. He had used plywood plates which were coated on both sides with steel $\frac{1}{16}$ in. thick quite successfully.

MR. MEASURES said he would have no hesitation in mounting patterns on wood boards for a quantity of 1,000 moulds.

Renewable Bushes Preferred

MR. T. A. SPIERS said he entirely agreed with the author on the question of the designer; if some of the "old-timers" had gone into consultation with the designers years ago, the business would be better for it to-day. Referring to box parts, he thought drilling the lugs was the wrong method; he preferred the renewable bush, but thought the cast-iron bush superior to the brass bushes mentioned.

MR. YEOMANS asked whether Mr. Gale would recommend any of the machines described if

(*Concluded on page* 114.)

Birmingham Foundrymen's Annual Dinner and Dance

Members and their ladies, numbering well over 200, met at the Edgbaston Botanical Gardens, Birmingham, last Saturday, for the annual dinner and dance of the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen. Mr. L. W. Bolton, A.M.I.Mech.E. (Branch-President), was in the chair, and the guests included Dr. D. S. Anderson, A.R.I.C. (Principal of Birmingham Central Technical College), and Mr. J. E. Hurst (Past-President of the Institute).

The Loyal Toast having been honoured, that of the "Birmingham, Coventry and West Midlands Branch" was submitted by DR. D. S. ANDERSON. The objects of any technical institution, he said, might be summarised under three heads. The first was the pooling of interesting experiences and knowledge for the benefit of members, which was done through the medium of Papers, conferences, etc. The second object he would define as the stimulation and encouragement of research for new knowledge, and the third object should be the stimulation, encouraging and advising upon the establishment of courses for the training of young people. The Branch was admirably carrying out all three functions. With regard to the stimulation and encouragement of research they were working in close collaboration with the British Cast Iron Research Association. In their third object they were closely associated with the City Guilds and institutes, and also the British Foundry School, which was housed in his own institution.

The foundry industry was the basis of a great deal of the huge engineering industry in this country, for unless one started with a sound casting the ultimate product could not be satisfactory. The responsibility resting upon the shoulders of the foundryman was a heavy one. He knew no trade which made contact with so many of the other sciences, such as chemistry, physics, metallurgy and engineering, and not only with the fundamentals of those sciences, but their most advanced developments.

The standard of technical training was as high in the foundry trade as in any other. It was probably for that reason that one hoped to see the best results from the British Foundry School, which was a kind of finishing school in the education of foundrymen. He thought that the School would send out its students with a profound respect for the difficulties and intricacies of the science of founding. The large list of specialised lectures held in connection with that school was a most admirable feature of its activities. He understood that next July the Institute was going to have a new constitution. Amongst other things, it was introducing an examination, and after that date members would have to pass an examination before being accepted by the Council. He thought that was a very good move. Although it was the fashion in these days to decry examinations, an examination did test a man's ability to think clearly and concisely when under a certain nervous strain, and that was a valuable quality to test. He knew no job of responsibility which did not involve nervous strain the whole of the time, and, that being so, a man who could not think clearly under a slight nervous strain was of no use in that job. In conclusion, Dr. Anderson coupled with the toast the name of the Branch-President.

Birmingham's Part in the International Conference

MR. L. W. BOLTON, in the course of his response, thanked Dr. Anderson for his complimentary remarks concerning the efforts the Institute was making in the educational direction, and also in raising the status of the industry by instituting examinations for people wishing to join. In a few words on international affairs, Mr. Bolton said that, apart from the fact that the Institute had members in almost every industrial country of the world, it also had a system of exchanging Papers which members read to overseas foundry associations. There were also committees on which the Institute was represented, and recently Mr. J. E. Hurst, whom they were pleased to have with them, was elected chairman of the International Committee for the Testing of Cast Iron. That was a great honour not only for Mr. Hurst, but also for the Institute. He reminded members that Mr. Hurst was deputising for the President, Mr. J. Hepworth, M.P., who was unable to be present.

Members of the Institute were each year invited to attend the International Conference which was held in various countries, and anyone who had attended that conference would have noticed what nice people the foreign foundrymen were. They were always anxious to discuss their work, and show the visitor what they were doing. This year's International Conference was being held in London from June 13 to 17. He expressed the hope that members of the Branch would make every effort to attend that Conference and to give a hearty welcome to overseas delegates, and endeavour to show them the hospitality meted out to them when they visited other countries. An interesting series of Papers, visits and social events were being prepared, and following the Conference the overseas delegates would make a tour of some of the more important industrial centres, starting, he believed rightly, with Birmingham on June 18, 19 and 20. On the first day the Branch hoped to entertain them to dinner, and he urged members and their ladies to attend that function. He wished to thank the Council of the Birmingham Branch for the support they had given him, and were giving him, during his year of office. He especially thanked their hon. secretary, Mr. Timmins. Anyone who had attempted to organise a function like the annual dinner would know that it entailed a vast amount of work. Mr. Timmins had undertaken the task quite cheerfully, and if everyone enjoyed themselves that night, he would feel amply repaid for his trouble. In conclusion, he thanked Dr. Anderson for the enthusiastic way in which he had proposed the toast, and the guests for the way in which they received it.

"The Guests" was briefly submitted by MR. A. TIPPER, who remarked how sincerely they appreciated the presence of Mr. and Mrs. Hurst. A year ago Mr. Hurst was seriously ill, and all were happy to know he had made such a remarkable recovery. They appreciated the nice things Dr. Anderson had said about foundrymen. The difficult task he had as Principal of the Technical College was not generally recognised in view of the increasing demand for better and bigger technical education. They were also delighted to see Dr. Johnson, another member of the staff. The younger members would find him most willing to guide them in their studies and to help them in any way. They were glad to see the education authorities taking keen interest in the Institute of British Foundrymen. They had also with them Mr. Makemson, the General Secretary of the Institute, and two gentlemen who had given them Papers, Mr. G. L. Harbach and Mr. A. Allison.

Responding, MR. J. E. HURST jocularly remarked that had the President been present he might have talked on political matters. However, all would feel that to attempt to make a political speech at a dinner in Birmingham that night would be absolutely wrong. The ears of the world were fixed on Birmingham at that moment, for all eagerly anticipated the words of the Prime Minister, who was the chief speaker at the Birmingham Jewellers' Dinner. He wished to thank Mr. Tipper for the kind references to himself, and to express thanks for the warm hospitality shown by the Branch to its guests.

An adjournment was then made to the ballroom, where, with Mr. J. W. Gardom and Mr. W. Todd officiating as M.C.'s, the three hours prior to midnight passed all too swiftly.

Machine-Moulding

(*Concluded from page* 113.)

he was getting 100 moulds per day off loose patterns, or 120 moulds per half-day off plate moulding. Regarding mounting of patterns, Mr. Yeomans advocated the metal pattern-plate in every case.

MR. GALE pointed out that, without knowledge of the actual jobs stated, he could not indicate which machine he would recommend. It was a question of price; if he could show a saving or increased production, then he would introduce the machine, but not otherwise.

Master Pattern-Plates

MR. GOODWIN said there had been a vast improvement in design. It had been said that the "old-timers" were to blame in the matter of design. He believed he was correct in saying that he had the job of making the first cylinder and crankcase combined, made in this country, and it was a nice job, which took two men three days to make. It was from the suggestion of the "old-timers" that the present-day designs were made. Mr. Gale had mentioned that he had not seen a foundry where a machine could not be introduced. He (the speaker) could name several where very good jobs were made and a machine would not be helpful. They never had sufficient off any one job to warrant the introduction of machines. There was one method no one had mentioned which was very useful in the foundry, especially if for using split patterns, and that was to have a master pattern-plate with a certain number of drilled holes on the centre-lines of the plate. It was not a big job for the patternmaker to mark out the jobs to be assembled on to the master plate, so that it could be removed and refitted to the same setting as often as the job came along.

MR. LUCAS expressed surprise that no mention had been made of making cores on machines. He knew Mr. Gale had a great deal of experience in that direction.

MR. GALE said he had purposely omitted the question of cores from the Paper as that was a subject sufficiently wide to warrant a Paper of its own. In the foundry making small or moderate quantities he thought it was very often an advantage to use cores to make up irregular joints, but in the repetition foundry where pattern cost was not so important it was generally advisable to make special pattern-plant to eliminate core-making.

MR. A. E. PEACE, proposing a vote of thanks, recalled that it had always been said that the value of a Paper lay in the discussion; and he felt that Mr. Gale should be very satisfied with his work.

MR. GALE briefly acknowledged the vote of thanks.

Anglo-German Industrial Talks

Arrangements have now been made for a delegation representing the Federation of British Industries to visit Germany for further discussions with the Reichsgruppe Industrie at the end of February. It is possible that the Federation's delegation may be accompanied by representatives of certain individual industries, in order that the latter may have simultaneous discussions with their individual "opposite numbers" in Germany. The exact composition of the delegation and the place of meeting have not yet been decided on.

Examples of Loam Moulding*

By R. D. LAWRIE

The use of loam has many advantages in the foundry, more particularly in the jobbing foundry. By its use the cost of patternmaking can in many instances be considerably reduced, and although it cannot be employed profitably in every case, there are certain classes of work for which it is eminently suited. Its primary value lies in the ease with which it can be swept to a given shape; in cylindrical work, for example, its use is both cheap and effective, a profiled edge board being all that is required in the way of a pattern. Such shapes may be swept either about a vertical or a horizontal spindle.

For castings of large diameter and short length, vertical sweeping is the method generally employed, whilst castings of which the diameter is small in comparison with the length are easier swept by the second method, *i.e.*, horizontal sweeping. Loam moulding is not necessarily confined to castings of a cylindrical shape, or those which can be shaped by sweeps or strickles; it is often necessary to employ a part-pattern in conjunction with sweeps, where the shape of the mould deviates from the circular. Loam is also the method usually employed when the pattern is too large for the moulding tackle available, or when the size and shape of the pattern are such that the mould has to be split into irregular shapes to facilitate either handling, drying, pattern removal, or the placing of cores during closing.

MOULDING A BORING BAR

Fig. 1 shows an arrangement drawing of a boring bar 36 in. dia. and 56 ft. long. The bar was made up from two separate castings, one 31 ft. and the other 25 ft. long, and weighing as cast 25 and 20 tons respectively. The moulds for these castings were swept in loam, partly by horizontal sweeping and partly by horizontal strickling. The larger casting was made first, the mould being built inside a cast-iron casing 4 ft. square inside and 36 ft. long, split longitudinally and machined on the adjoining faces.

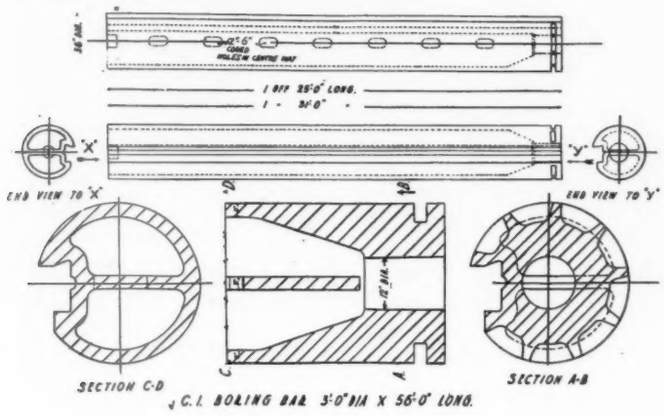

FIG. 1.—ARRANGEMENT DRAWING OF BORING BAR.

FIG. 2.—MOULD FOR 31-FT. CASTING FOR BORING BAR, WITH SWEEPING TACKLE ON RIGHT.

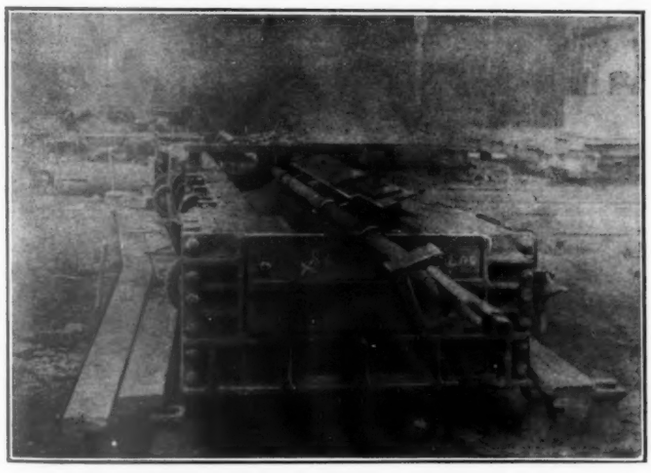

FIG. 3.—MOULD WITH SWEEPING TACKLE IN PLACE.

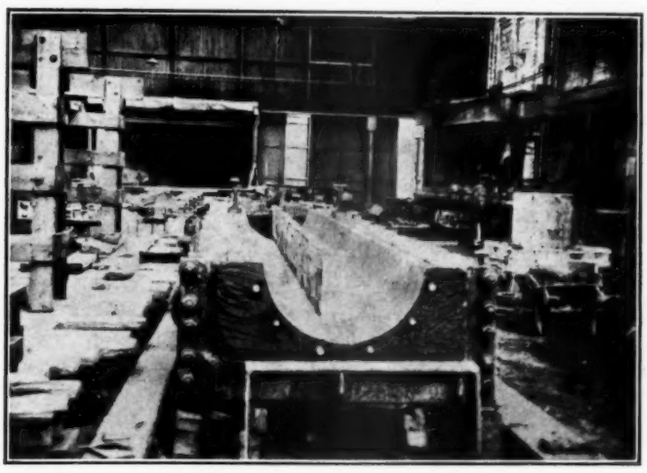

FIG. 4.—ARRANGEMENT FOR MIDDLE RIB.

Strickling Tackle

The sweeping tackle employed consisted of a hollow steel spindle 3½ in. outside diameter and 36 ft. long, supported in bearings at either end of the casing, also about the middle of its length in a bearing slung from the underside of a mild steel channel which straddles the casing. The end bearings, which are interchangeable, are dowelled and bolted to the ends of the casing. (See Figs. 2 and 3.)

The sweep or profile board is fastened to the spindle by six shear arms and revolves with the spindle, a cranked handle being attached to each end of the spindle for this purpose. The mould is built up with bricks to within an inch of the profile board and a coating of wet loam applied to the face of the bricks; the profile board is rotated and the loam is brought to the desired shape.

Making the Joint

The joint is strickled off by means of a steel straight edge about 6 ft. long and 6 in. deep, having a recess 12 in. by 1¾ in. in the middle of its length, so that it rests on the spindle and the edges of the casing simultaneously. After the bottom half of the mould is swept up, the spindle and board are transferred to the other half of the casing and the top portion of the mould is made up in exactly the same manner as the bottom. The recess for the screw is formed in the top half-mould, and is shaped by a wooden frame which is placed inside the top half-mould and packed with loam and bricks, reinforced with gratings keyed through to the outside of the casing.

The spindle is next returned to the bottom half-mould, the original board removed and a new one substituted, which is cut to the profile of the inside of the casting. It will be appre-

* Paper read before the Lancashire Branch of the Institute of British Foundrymen.

ciated that this latter board will be clear of the surface previously swept, by a distance equal to the desired thickness of the casting. This space is now packed with damp moulding sand and swept to the shape of the board, and forms what is known as the core box.

Moulding the Middle Rib

The middle rib—originally designed solid—was provided, at the request of the foundry, with a series of holes 12 in. by 6 in. spaced at 3-ft. centres, and is now placed in position in the core box. For the purpose of effecting its removal, the rib is split longitudinally through the centre of the holes. (See Fig. 4.) A parting wash is next applied to the surface of the core box which is now ready to receive the core-iron.

Preparing the Core-Iron

The core-iron consists of two 6½-in. dia. perforated steel tubes carrying a series of cast-iron grids with dabbers or prods, which encircle both bars, and having cross-bars which pass through the 12-in. by 6-in. holes in the centre rib. The holes in these grids are made ¼ in. larger in diameter than the tubes which they encircle, and are wedged in position by small mild-steel wedges which are all placed with their points facing towards the bottom end of the casting, *i.e.*, the end with the small opening. Owing to the small diameter at the bottom end of the casting the tubes stop at a point where the metal thickens up, some 2 ft. 6 in. from the end of the casting.

Into the end of each tube is fitted a cast-iron block 12 in. long with a 2¼-in. square hole running lengthwise and a 4⅛-in. long by 1⅛-in. hole crosswise. These blocks are secured by six ¾-in. dia. countersunk screws and a hole through the tube connects with the hole in the block. Into the ends of these tubes are placed mild-steel connecting links 2 in. by 2 in. tapering to 4 in. by 1 in., with an offset so that they meet at a point some inches from their ends, terminating in a head with a cotter hole 4⅛ in. by 2⅛ in. Fig. 5 shows details of the twin core bars, cross grids and connecting links. It will be apparent that the core-iron is now in one piece and perfectly rigid.

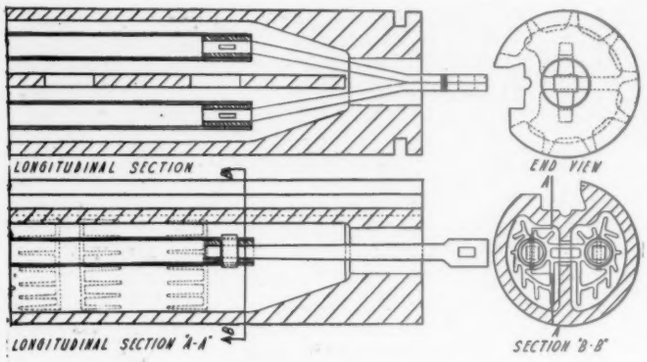

FIG. 5.—DETAILS OF CORE BARS, CROSS GRIDS AND CONNECTING LINKS.

The offset links are bolted together just clear of the casting, and the ends which fit inside the two tubes are secured by a 4-in. by 1-in. cotter pin. These cotter pins are an easy fit and are made to slide through from either side and project a matter of 1½ in. at each side of the tube. Fig. 6 shows the core bar completely assembled and ready to go into the core box. The body of the core is constructed of soft loam bricks and a good layer of ashes, about 4 in. behind the face of the core, connected to the perforations in the tubes by short lengths of straw rope to permit free escape of air and gases during casting. The top half of the core is shaped by strickles which run on steel straightedges laid along the joints of the mould.

Core-Handling

Fig. 7 shows the core at this stage with the strickle in position resting on the steel straightedges. The eye bolts seen projecting are for the purpose of slinging the core and are screwed into the twin core tubes. At this stage the bottom half-mould and core are placed in a stove and dried sufficiently to lift the core out of its box; then any breakages are repaired and the core is given a coat of liquid blackwash and returned independently to the stove for complete drying. The sand thickness is removed from the core box, leaving the original swept surface, which is blackened in a like manner to the core; the top is treated also with blacking and the whole job dried off in the stove.

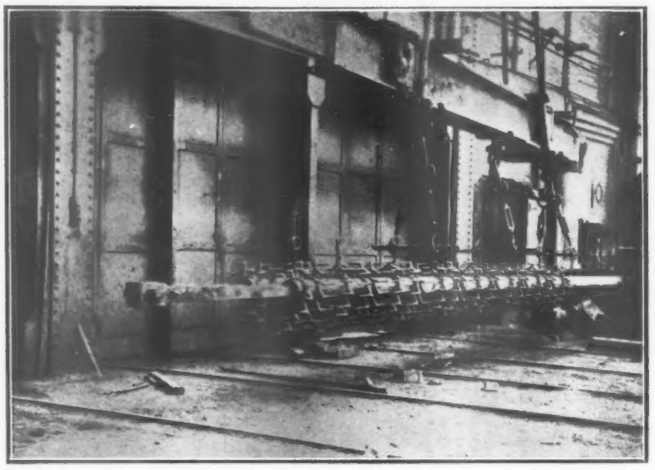

FIG. 6.—CORE BAR COMPLETELY ASSEMBLED.

After drying, the core is placed in the bottom half of the mould, supported by prints at each end and at intervals along its length by mild-steel chaplets. Fig. 8 shows the mould at this stage with the core in position looking from the top end. Fig. 9 is a view from the opposite end. After the mould had been assembled it was lowered into a casting pit in a vertical position for casting.

Casting Arrangements

Fig. 10 shows the commencement of this operation; it will be observed that the mould is slung by one end from the overhead crane, whilst the opposite end rests on trunnions. Fig. 11 shows the mould ready for casting. Two ladles were used to fill the mould, one pouring direct into the rectangular pouring basin, while the second ladle poured into an auxiliary runner trough connected to the aforementioned main basin. The core itself protrudes through the top of the casing and can be seen clearly in the centre of the pouring basin.

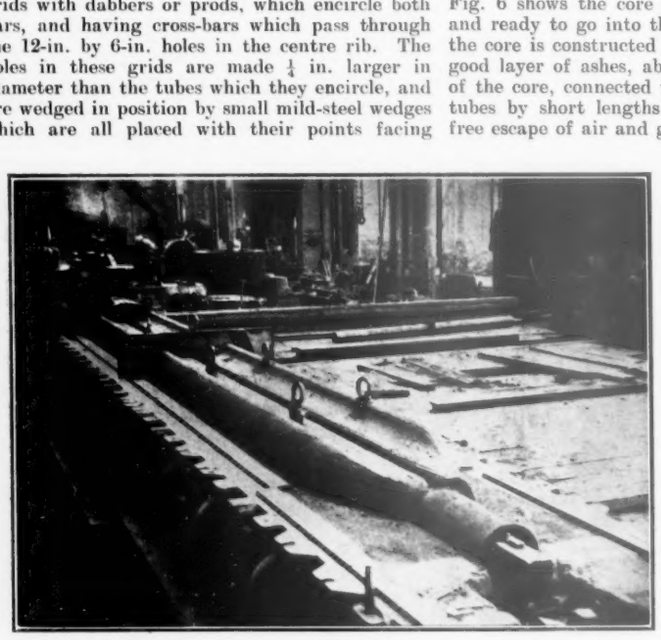

FIG. 7.—TOP HALF OF CORE IN PROCESS OF STRICKLING.

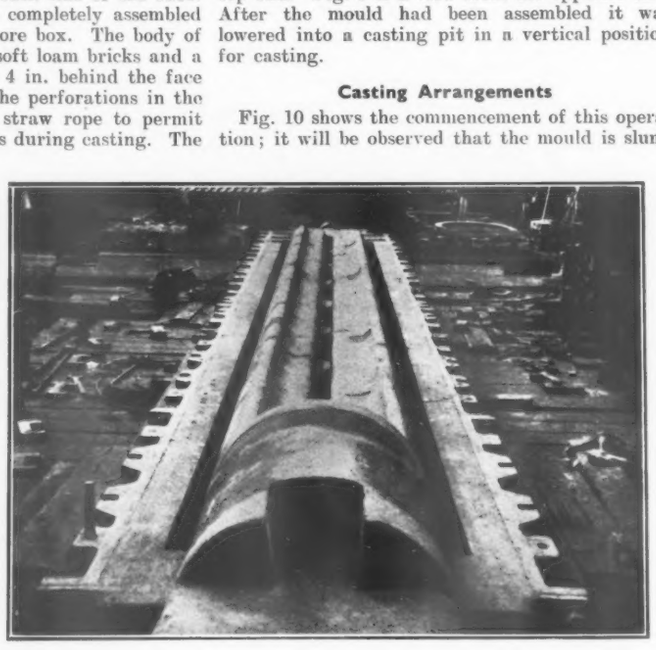

FIG. 8.—MOULD WITH CORE IN POSITION, VIEWED FROM TOP END.

Metal was introduced through nine 1¼-in. dia. gates, spaced round the outer metal thickness (see Figs. 4 and 8). It will be noticed that Fig. 4 shows six gates formed in the bottom half of the mould, whilst Fig. 8 shows three gates formed in the core itself; this is due to the change of contour of the casting. Referring back to Fig. 1, it will be observed that there are eight recesses near the bottom end of the casting. As these recesses were cored out it will be obvious that to allow molten metal to fall on to these cores from a height of 36 ft. would be attended with disastrous results. To guard against this, during the actual casting operation metal was first introduced through a single gate located on the centre line of the rib, midway between the rib and the recess for the screw (Fig. 8). After sufficient metal had been allowed to enter the mould through this single gate, to cover the projecting cores to a safe depth, pouring was continued through the remainder of the gates until the mould was completely filled.

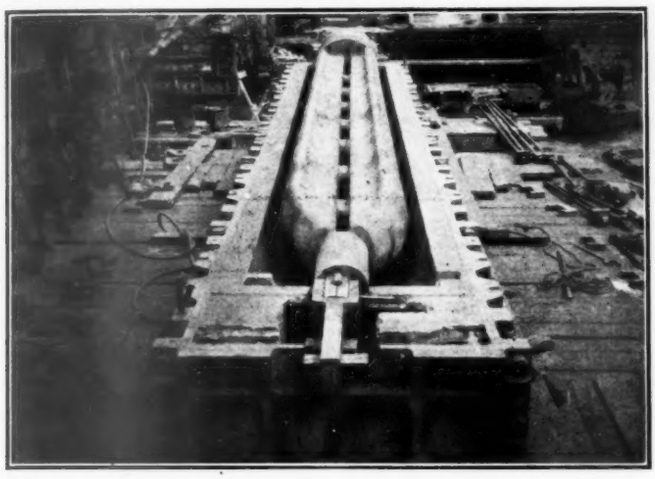

FIG. 9.—AS FIG. 8, VIEWED FROM THE OPPOSITE END.

FIG. 11.—MOULD READY FOR CASTING.

Stripping and Fettling

After an interval of a week had elapsed, to permit thorough cooling and normalising to take place, the casting was removed from its mould and fettled ready for machining. The removal of the offset links from the bottom end of the twin core-bars was a slow and arduous job, as the amount of space available was extremely small. The internal core was removed as far as the cotter pins which dropped down clear of the core bars, these being subsequently withdrawn from the top end.

Earlier in these notes reference was made to the manner in which the grids were wedged to the twin bars. The object of having the wedges pointing towards the bottom end of the casting was that during the pulling out of the core bars the wedges cleared themselves. When once the bars had been removed from the casting, the remaining cast-iron grids were easily broken out and the inside cleaned out of all debris and the casting removed to the machine shop.

Analysis of Casting:—T.C., 3.19; Si, 1.08; Mn, 1.03; P, 0.28, and S, 0.04 per cent. The casting temperature was 1,240 deg. C., and the pouring time, 125 secs.

(To be continued.)

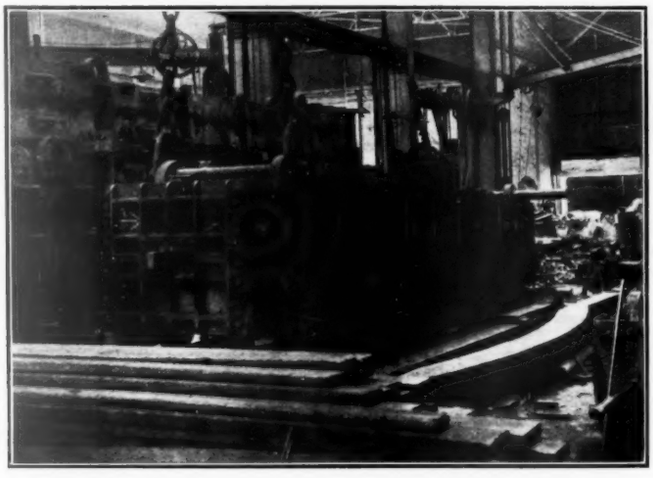

FIG. 10.—ARRANGEMENT FOR LOWERING MOULD INTO CASTING PIT.

Founders Company Fellowships

The Worshipful Company of Founders of the City of London, to whom Ordinances were granted as long ago as July 29, 1365, was originally formed for the purpose of ensuring that work by founders in the City of London should only be with good metal. Recently, the Master, Wardens and Court of Assistants, after discussion with various members and bodies associated with the foundry industry, decided that the development and progress of founding and the science of metallurgy must depend very largely on attracting to the industry highly-trained men of outstanding talent. To that end the Company has decided to award Fellowships so as to give facilities for advanced education to men who have already completed their normal course of training.

These Fellowships, to be called "Founders Company Fellowships," will be available to those graduates who appear likely to be able to make good their careers in the foundry industry if afforded the facilities for further courses of study designed specially to qualify them towards that end. Fellows will be chosen by a selection committee from among applicants who have completed such academic training in chemistry and physics and allied sciences as is usually associated with an honours degree. In their selection the committee will pay considerable attention to the character and powers of initiative of the candidate.

The course to be followed by the Fellow will in each case be chosen with the object of adding to his scientific equipment that which appears to be most necessary for adapting him to some branch of the industry. There will be no limitation to the nature of the course which may be selected; it might include research, a period in works or foreign experience, due regard being paid to the particular wishes and aptitude of the Fellow. The normal value of the Fellowship will be £250 per annum, and it will be renewable for a second year and in special cases for a third year. Payment will be made monthly in advance to the Fellow's bank.

One Fellowship will be granted each year so that, in ordinary circumstances, after the first year there will be two Fellowships in existence. The Fellow will be expected to devote his whole time to work approved by the Company and to submit periodical reports of progress, if required. No other work for which payment would be received shall be undertaken by him without the consent of the Master of the Company and no other grant, scholarship or Fellowship shall be

(Concluded from next column.)

held concurrently with the Fellowship unless the selection committee approve.

Candidates should not be less than 21 years of age on September 1 of the year of application and will be required to furnish particulars of their name, address, age, and academic and other training, etc. They will subsequently be required to attend before the selection committee. The tenure of the Fellowship will date from September 1.

Applications must be received not later than May 1 by Mr. H. Wilson Wiley, the Clerk of the Worshipful Company of Founders, Founders' Hall, 13, St. Swithin's Lane, London, E.C.4.

(Concluded from previous column.)

Some Impressions of Modern Foundry Practice*

By H. LOWE

The adage that "there is nothing new under the sun" must have been written for the consolation of those who never tried to find anything new, rather than for the men who have spent years or even a lifetime in bringing to light some principle or invention. Literally, the adage is true enough; but, in any event, there is one thing for which men should get credit, and that is the improvements they make on old tricks. The different ways there are of doing the same things can only be accounted for by men's minds travelling through different channels to achieve the same result.

There are all kinds of old tricks or plans in every occupation and in this the moulder seems to have been provided for just as well as other craftsmen. If he would only search them out, he would be astonished at the number he could find.

Pig-Iron

Iron, to be suitable for foundry purposes, must have the properties of being readily reduced to such a state that it can be carried in ladles for a reasonable length of time, and still be sufficiently liquid to run into and occupy the most minute spaces in a mould. Otherwise, it would not be possible to produce the many intricate castings required, such as engine and machine-tool parts, and also the highly ornamental iron castings frequently met with in structural ironwork.

It may be pointed out here that such iron compounds, now so well known as cast iron or pig-iron, are comparatively modern products when compared with the purer and more malleable qualities of iron capable of being welded, drawn or shaped under a hammer when raised to a suitable heat. That the latter malleable qualities should have been the only products from the early smelters was due, naturally, to the primitive methods then adopted and practised more recently in Catalonia, in Spain. The furnace and general procedure in the latter case is known as the Catalan process.

The quality of iron produced by this process varied, even in the same mass (as it left the furnace), from soft to steely iron, owing to the lack of uniformity in the decarbonising effects of the air blast, along with the oxide of iron present in the slag and the ground iron ore which formed the bottom of the furnace. All these things, it will be readily understood, acted more directly, and therefore more effectively, on the surface of the mass towards the end of the process.

As the demand for iron manufacture increased, smelters began to enlarge the dimensions of their furnaces. The irons, too, which previously might not have been considered pure or rich enough, were now being used with the result that, accidentally, now and then, a highly liquid quality of iron was produced. For a long time, this liquid iron, produced by reason of the higher percentage it contained of carbon, silicon or other elements, was considered to be worse than useless, because it had to be run off in the same way as slag.

Genesis of Ironfounding

Later it was found that, by subjecting this liquid iron to the influence of air directed through it, or by stirring it so as to expose its interior as much as possible to the direct influence of an oxidising atmosphere, the metal became thickened. This method is practised in the well-known puddling process, and is due to the removal of the previously combined carbon leaving the iron comparatively pure and malleable.

After it had been found that the liquid metal could be favourably treated, and its production had become more general, it seemed natural that someone should suggest the direct use of this liquid iron by pouring it into moulds which could be easily formed in the earthen floor near the furnace.

The earliest efforts in this direction, and apparently those marking the introduction of iron-foundry practice, were some simple castings in the form of chimney backs and grave slabs, unearthed in the South of England. These were found to have the year "1550" cast on, and this serves to indicate clearly the date of their origin.

Later on, in 1595, there was evidence of a considerable development in the art of ironfounding; in this year, cast-iron cannons were being produced, weighing up to 3 tons each. In 1685, it was found that the first cast-iron pipes were made and used for the Marseilles water supply. This latter date marks the beginning of one of the most important branches of ironfounding.

To-day, on account of the rapidity with which pig-iron and scrap can be reduced to the necessary molten condition in it, the cupola claims the special attention of the foundryman. The cupola is marked by simplicity of construction and economy in operation.

General Foundry Conditions

It is impossible to lay down hard-and-fast rules describing what would be considered the best arrangement and most suitable features for all foundries. The varying conditions with regard to quantity, quality and cost, and the nature of the work coming within the scope of each individual plant, largely determine the methods to be adopted. Equipment that gives the best results in one case may prove a failure in another. It must be understood, therefore, that in describing modern foundries and the various machines and systems forming part of their equipment, much of what is now being said is ideal in its nature. No two foundries have conditions exactly alike; and so, from the many styles of building and the various appliances available, it becomes necessary to work out and arrange each case according to the speciality to be manufactured in it. Thus the designing of a modern foundry requires considerable experience and good judgment on the part of the manager or engineer in charge.

It is the author's opinion that, when a new foundry is to be planned, there should be appointed a committee of five or six, consisting of the following members of the staff:—Works manager, foundry manager, metallurgist, draughtsman, patternmaker, and a clerk to take a note of the proceedings. By this method the work should go forward smoothly, as each section would know what the others were doing.

A proper ventilation system, delivering warm air in winter and cool air in the summer, should be installed, and arrangements should be made for the rapid removal of all the dust, smoke and fumes caused during the casting operations. Perhaps in these directions, more than in any others, lies the great difference between the old foundry and the new.

Moulding Machines

In moulding operations much work has still to be done by hand. Many patterns are so complicated that it is not practicable to deal with them otherwise, and the extra cost of preparing them for machine-moulding in many cases rules out any possibility of this being done.

The usefulness of hand machines is obviously limited by the limitations of manual labour. The capacity of power machines may also be limited in cases; for instance, (*a*) when the job is a large one; (*b*) when the degree of ramming is excessive, due either to the pattern being very deep or to its having pockets; and (*c*) when a large supply of cores is necessary.

A great number of different types of moulding machines are now on the market, and much care must be exercised in making a selection. Many of these machines are really the result of designing them to suit some special line of work, and their general usefulness is thereby limited.

In making his selection the foundry manager should keep clearly in mind exactly what he proposes to make on the machine, and be guided accordingly. If about to instal them for the first time, or if contemplating a change from one type of machine to another, he should also keep in mind, in addition to the cost of the machine, the extent to which his choice will involve additional cost for boxes, pattern-plates and other necessary items. In a general way it can be said that the more extensively the foundry engages in repetition work, the greater is the justification for the installation of moulding machines, but it must also be remembered that the greater the variety of work the greater will be the difficulty in getting just the right machine.

Types of Moulding Machines

Broadly speaking, the machines and the class of work for which they should be used may be conveniently grouped as follows:—

Pressure Machines.—These machines are suitable for shallow work, for work having plenty of taper, and also for circular work.

Stripping Plate Machines.—This class of machine should be used for deep work, for work having very little taper, or work having square corners, while various other jobs such as gear wheels, or jobs having an intricate outline along the jointing edges, can be easily made on them.

Jar-Ramming Machines.—Plain jar-ramming or jolt machines are specially suitable for deep work and for work which may be only moderately deep but have recesses or pockets. They are also much used for large heavy moulds, and in some cases machines are fitted with a combination of jolt and squeeze, which greatly increases their range of usefulness.

Much has been said as to the relative merits of hydraulic and pneumatic machines, but each has its own advantages. There is still some difficulty in getting uniform ramming in deep moulds with the hydraulic machine, although specially-designed machines have been made which have now largely overcome this difficulty. Pneumatic power has one outstanding advantage over hydraulic power, since compressed air can be used for either squeeze or jar-ram machines, while it has a wide use also for the operation of pneumatic hammers, rammers, mould cleaners, vibrators and sand sifters, etc.

Oil-Sand Practice

The use of oil sand has to some extent revolutionised the foundry, as it has eliminated the use of cast core irons and has greatly reduced the skill required for core making. This is so much the case that even intricate cores are easily made, and are so reliable in oil sand that it has helped greatly to reduce the number of "wasters."

There is a common belief in the foundry that oil-sand cores do not require venting, but this is not the case. All oil-sand cores require the vent to be taken off. All moulding sands contain gases, and provision must be made for their removal; otherwise trouble will surely follow,

* Paper read before the Scottish Branch of the Institute of British Foundrymen, Mr. Robert Ballantine presiding. The author is foundry manager of the St. Rollox Works, L.M.S. Railway.

but it is true to say that there is not the same need for excessive care in the case of the oil sand. This, and the simplicity in making the core, constitute two of the great advantages of the oil sand. Care must be taken in baking the core. A suitable temperature is about 200 deg. C., the time allowed depending on the thickness of sand in the core.

Modern Drying Methods

A well-dried loam or dry-sand mould is an essential point in the making of a casting that will be free from scabs. Some irregularity may be permissible in the mixing of the loam or blacking, but the mould should be thoroughly dried.

When the water in a damp mould is heated, it is converted into steam, and steam, when confined, creates pressure. Iron when poured into a mould heats the interior surfaces, and this heat generates steam if there is any moisture present. The mould is rarely strong enough or close enough to hold the resultant pressure, which increases until it forces an opening through which it can escape. This may be towards the surface away from the iron, but as the outside of a mould is generally encased in an iron box, or held by curbing between which and the brickwork sand is rammed hard and compact, the steam is more likely to seek an outlet by moving towards the inside of the mould where the sand is more porous. If this takes place, scabbing is almost certain to result.

It may be asked, "Why does not a green-sand mould scab? The sand is damp." True, the sand is damp, but there is a certain limit to the dampness, which, if overreached, will cause trouble. The surface of a loam or dry-sand mould is generally hard and close compared with a green-sand mould, which is generally sufficiently permeable to permit the steam generated at the surface to pass through the sand and so escape to the atmosphere.

A green-sand mould that has been rammed too hard, and a loam or dry-sand mould that has not been properly dried, are very much alike so far as the effect of the molten metal on them.

Whether a loam or dry-sand mould is dry or not very often depends entirely on guesswork. The moulder will say it looks dry, and has been in the stove for such a long time that it must be dry. Unfortunately, the appearance of the mould surface, and the length of time the mould has been in the stove cannot be depended on as proof of dryness. It may be that the oven has not been working well, that the moisture-laden air has not been removed from the stove, or that there has been some neglect by the fireman. The fire may have been very hot for a short time, thereby burning or scorching the mould surface, while the interior is not even half dried.

Recently much has been done to raise the efficiency of mould and core ovens. It looks a simple matter to drive out moisture and make moulds and cores quite dry, but it is not quite so easy as it looks. Especially in the matter of oil-sand cores the drying temperature has much to do with efficient drying. Earlier methods in use involved intense heating and often resulted in baked cores which were very brittle and liable to internal cracks and fractures. Slower drying with efficient temperature control has resulted in the production of more satisfactory cores.

One of the advantages of oil-sand cores over the other types is the reduction, and in some cases the elimination, of cast-iron core-irons, owing to the former being so much stronger. Again, the oil-sand core can be much more cheaply and simply made, and can be removed from the casting much more easily during fettling. Assuming that the proper mixture has been used, and properly dried, the oil-sand core is hard and strong, easy to handle without crumbling or breaking, and yet is easily removed from the casting.

The modern method of drying moulds and cores is by temperature control. The time required for drying depends largely upon the size and character of the moulds and cores, but as a guide it may be taken that oil-sand cores should be dried at a temperature of, say, 200 deg. C. for 4 hours, or 150 deg. C. for 6 hours, and moulds should be dried at, say, 425 deg. C. for 6 hours, or 315 deg. C. for 8 hours.

Many large stoves are simply large brick chambers which have as a heating unit an open grate from the inside of the stove or a closed fire grate outside the stove. The best construction is a stove with flues arranged from an outside fire box so as to allow an even current of hot air to pass into the heating chamber, with a proper recording instrument placed outside, by means of which a record of time and temperature can be easily seen. This enables the foundry manager to know definitely what has taken place inside the stove, and removes the risk of decisions based on the appearance of a mould surface, or a statement by the fireman that everything is all right.

Sand Conveyors

In ordinary practice, castings, whether made in boxes or by "bedding-in" on the floor, are generally knocked out at or very near the place where they are cast. In such cases, the sand is usually mixed by hand and used over and over again. From time to time some of the worst burnt sand is rejected and fresh sand added to take its place.

When lighter or finer types of castings are made, or where many cores are used, or a great many sprigs or core irons are required, the preparation of the sand becomes a much more costly operation, and accordingly various systems of conveyors and machines are brought into use for this purpose. This is particularly true in the case of shops where many duplicate small moulds must be made. In general, it may be said that as the time required to prepare the sand when compared with time required to make the mould increases, so will increase the saving to be obtained from the preparation of the sand by mechanical means.

In some cases, where bench moulding at stationary benches is the general practice, it will be found advantageous to distribute the sand by means of an automatic trolley system, but generally a more complete system of sand distribution is recommended.

A complete system of sand distribution would include an underground conveyor to take the sand from the knock-out station, a crusher, a mixer, a magnetic separator with distributing shutes for returning the sand to the foundry floor. Some types of plant are made to serve a number of machines and consist of an underground belt passing the side of the machines, from which it receives the spill sand from the mould boxes. The spill sand is conveyed from this belt by a cross belt, and is discharged on to the main belt which also receives the sand from the knock-out. The main belt discharges the sand into an elevator, which in turn discharges into a storage tank capable of holding 22 tons of sand. From the storage tank the sand falls on to a conveyor belt on to which there are also fed supplies of new sand and coal-dust. This sand then passes by means of another elevator to a rotary screen, thence to a mill where moisture is added, up another elevator, through a distintegrator, and so on to an overhead belt from which it is ploughed into hoppers situated above the moulding machines. Samples are taken from the plant by the metallurgical assistant, who tests it for permeability, green bond, dry strength and moisture content.

It is the author's opinion that the manufacturers of sand mixing and distributing plants should make them capable of working to a definite specification of sand, having regard to the class of work to be made in the foundry. It must be admitted, however, that the problem is much more difficult where a variety of castings of different weights and thickness are to be made. There is an old saying to the effect that the same sand is not suited for every casting. This is true, but when a uniform sand is to be used in the shop, the plant should be designed to give suitable sand for the heaviest castings.

There are many things to be considered when installing a sand plant, and one of the most important is the casting temperature. In certain shops it may be necessary to cast several boxes from the same ladle. The first may be cast at 1,340 deg. C. and the last at 1,280 deg. The sand should be made suitable to meet these varying requirements, and in these days of scientific control the author can see no reason why the requirements should not be met.

Another point that should receive particular care from the designers of sand plants is the question of dust. There is always dust and silt floating about in foundries, but the properly-designed sand plant would take care of this dust, by collecting it, as much as possible, at the points where it is created or disturbed, and conveying it to some suitable dust-collecting hopper. Even in the construction of the shop, the girders and beams should be made in such a way that dust would not collect and build itself up on them. This could be done by having the top surfaces made in the form of an inverted V.

Scabbing

From the reading of existing foundry literature it would appear that the behaviour of moulding sand during the casting process has not received the attention it deserves. For example, one is told something on these lines:—

> The sand works loose from the mould wall and falls on the metal; the sand particles are then carried to other parts of the mould, and very often cause a casting to be rejected. Sometimes the castings show more or less deep grooves, which indicate that the surface has expanded, burst and bulged out. It is a well-known fact that different moulding sands act differently on the scabbing of a casting; in addition, such factors as the pouring temperature, pouring time, casting thickness, density of ramming and the form of the mould face all influence the tendency of a casting to scab. One is told that low pouring temperature, short pouring time, casting thickness and soft ramming all help to avoid scabbing, and that the pouring of the metal must be completed before any part of the mould surface is heated to the critical temperature at which the sand grains expand or the clay loses its bond.

All this is quite true, but what of the difficulties which prevent the foundryman getting the perfection for which he is striving? Metal has to be kept in the ladle for a long time; it has to be carried comparatively long distances; from the same supply of metal in the ladle the first and also the last boxes in a row must be cast; gates are cut to the same size and shape, in each box, and if these are just right for the hottest of the metal, then they are not quite right for the coldest. This is a point which is too often forgotten, and it seems to the author that the gates should be formed to take the metal at the lowest temperature at which any of the boxes are likely to be cast. Gating is a very special problem and ought to be dealt with in a Paper by itself.

In conclusion the author desires to express his thanks to the L.M.S. Railway for granting permission to publish the Paper.

Pig-iron and Defence

Mr. Alfred Edwards, M.P. for Middlesbrough East, speaking at the annual dinner of the Cleveland Institution of Engineers recently, asked if it was in the interests of defence that in these days we were deliberately putting men out of work by closing blast furnaces when we did not have as much iron stored as we had at the beginning of the war. He thought the iron and steel industry should demand that until danger was past every blast furnace should be kept going.

Electric Furnaces for Vitreous Enamelling*

By A. G. ROBIETTE, B.Sc.

Of the two distinct processes used for vitreous enamelling, namely, the dry and wet processes, electricity has found relatively little application to the dry process, which is mainly used for baths and other large cast-iron articles. The reason is presumably that electricity cannot show anything like comparable heating costs when large masses of material have to be reheated frequently, whilst the process is one which leaves a considerable amount of frit in the furnace, which does not improve the life of heating elements. The remarks which follow will therefore apply mainly to the wet process, and will include the firing of the ground coat and subsequent coats.

Primarily it might be fitting to describe some features of the construction of electric furnaces and their characteristics.

Furnace Construction

The type of electric furnace which is used for vitreous enamelling is the resistor furnace, heated by nickel-chromium resistors or heating elements. There are a multitude of types and forms of element used by different furnace manufacturers, each having certain advantages and drawbacks. The requirements of a satisfactory element are:—

(1) A long life should be given under prevailing furnace conditions.

(2) It should not be excessively expensive.

(3) It should be capable of being distributed over the furnace walls so as to give uniformity of heating.

(4) Replacement should be easy—although this condition is not so essential providing (1) is observed.

(5) The element should have adequate mechanical strength and should be protected from damage during charging operations.

(6) It should not be liable to excessive deterioration due to atmosphere conditions.

Some of the main types of element in use are made from heavy strip mounted in sinuous form on the furnace walls, coiled and straight rods supported by refractory, and heavy cast grids of special form.

Life of Elements

These elements are robust; they will, when properly designed, give a long life at enamelling temperatures, and most can be located to give uniformity of temperature. If contact with frit could be ruled out, a life of at least five years could be confidently expected. On the other hand, a heavy section of element operated at a low voltage from a step-down transformer is less likely to be affected by contact with frit than a flimsier element working from a normal supply voltage. A heavy cast grid element is, in this respect, undoubtedly the best. With this design it is possible to use hearth elements without a hearthplate. They are, of course, operated at an extremely low voltage.

A properly-designed element should give five years' service, if not more. A large furnace rated at 250 kw. has been in operation in this country for nearly six years, and only a few elements have been replaced, due to contact with frit. Others have been working similar periods.

The remainder of the furnace chamber follows conventional furnace design, except that electric furnaces in general are more heavily insulated than fuel-fired ones. They commonly have a 12 to 18 in. thickness of heat insulation, comprising the best qualities of diatomaceous brick.

Owing to the nature of the process, the door has to be very frequently opened for the insertion and withdrawal of the charge. For this reason large electric enamelling furnaces are often built with heating elements located on the inner face of the door. This serves to make up fairly rapidly for the loss of heat by radiation from the open door. Moreover, the doors on large furnaces are advantageously operated by motor or pneumatically. This not only conserves heat, but appreciably increases the output.

Perrets

For the supports for the work being enamelled, especially in electric furnaces, it is essential to have them made in a high-grade heat-resisting alloy. Iron scale is one of the most deleterious substances to come into contact with heating elements and brickwork, and will cause short-circuiting and incipient fusion of the refractory brick. It is well known that the use of cast iron and other such supports is going out in almost every type of enamelling furnace. The other factor is, of course, that nickel-chromium perrets and other supports need be so much lighter that the power consumption is considerably reduced, this being of much more importance when dealing with a dearer source of energy.

Types of Furnaces

All furnaces can be divided into two groups, namely, batch furnaces and continuous furnaces. Possibly there is another group which might be called semi-continuous, but this group need not be dealt with here as they have not, to the author's knowledge, been used for enamelling. In this country enamelling furnaces are mainly of the batch type, since they allow of small-scale production of a variety of work, and their flexibility is in many cases more important than the lower cost of the continuous plant.

In America continuous furnaces have found a very wide application but batch furnaces are still used in many shops where their flexibility suits the particular requirements of the work. Later a comparison of these types will be made.

Batch Furnace

This furnace in its more usual form consists merely of a rectangular chamber closed at one end with a rapid-acting door for charging and discharging. These latter operations, except in the small sizes, are effected mechanically by a rapid-acting charging machine having prongs or forks adapted to suit the particular type of work. Speed is the secret of economy in enamelling—hence the need for these devices.

In the electric furnace the temperature is almost invariably controlled automatically, and if the furnace is large the heating elements are split up into zones, each being separately and automatically regulated. Not only is it possible to vary the temperature but also the input, and the elements are graded (with or without door heating) to give uniformity of temperature in spite of the frequency of door opening.

The following figures relate to the average weekly operation of a furnace used for enamelling electric cooker and refrigerator parts. The effective dimensions of the furnace are 12 ft. long by 4 ft. 8 in. wide by 3 ft. 7 in. high, and it is rated at 250 kw., divided into two zones.

Over a period of 10 weeks the following data were recorded. The amount of work treated was 40,958 sq. ft., which was made up of 32,985 sq. ft. of sheet iron fired at 850 deg. C., 5,833 sq. ft. of cast iron fired at 750 deg. C., and 2,140 sq. ft. of annealing. The power consumption was 21,972 kw.-hrs. or 0.537 kw.-hrs. per sq. ft. At normal electricity rates this would be approximately ¼d. per sq. ft. The area of course refers to the area of enamelled surface. The firing time for sheet steel was 4.7 minutes and for castings 14.6 minutes. The time required for door operation was 6 seconds.

In general it is found that, for sheet steel work, the weight of work treated per unit or kw.-hr. is 3 to 6 lbs., depending upon the thickness and the size of the furnace. A good average figure would be 4½ lbs. per kw.-hr., which means that 9 lbs. could be enamelled for approximately 1d. For cast iron the efficiency measured in lbs. per kw.-hr. is higher and a figure of 8 lbs. per kw.-hr. can be taken as a good average.

Continuous Furnaces

The most generally employed furnace in the continuous class is the overhead conveyor type. The articles are suspended from an overhead chain and, more often than not, advantage is taken of the adaptability of this type of furnace to create recuperation by employing the well-known contra-flow principle. There are two variations of this type, namely, the straight-through design and the "horse shoe" or return-flow furnace. It is advantageous to raise the heating chamber so that its lower level is above the upper limit of the charging opening. This avoids the convection effect and provides what might be called a thermal seal. The hottest air is in the uppermost location and there is therefore no tendency for cold air to enter. The monorail conveyor runs outside the furnace from which rods are suspended and there is a seal to prevent air entry.

This seal takes the form of a completely enclosed box well out of the heat of the furnace, which means that the conveyor chain need only be made of mild steel and is taken through the shop to other operations in a completely mechanised plant. The pendant bars or rods which are suspended from the conveyor chain are of nickel-chromium heat-resisting alloy and they pass through the furnace roof with a sliding seal. These rods may carry racks for sheets or forks or other attachments suitably designed for carrying the work.

When recuperation is employed—as it mostly is—there are two chains running side-by-side in opposite directions. This applies to the

* Paper read before the Southern Section of the Institute of Vitreous Enamellers, Mr. W. Thomas presiding.

straight-through type of furnace. In the return-bend furnace there is only one chain which, after "doubling back," runs side-by-side with the ingoing part of the chain. The bend actually forms part of the heating chamber. This type of furnace can be adapted to smaller outputs and suits a layout where it is advantageous to have the material which is being treated discharged at a point near to the furnace inlet.

Most of these continuous furnaces which are placed in the line of production incorporate a preliminary drying chamber for wet enamels. Heating elements are provided in this zone. This is followed by the preheating recuperative section which is a plain chamber efficiently insulated. Then comes the firing chamber proper, also divided into zones to provide rapid and uniform heating. The work then proceeds to the cooling section where it transfers its heat to the ingoing work in the preheating zone. A typical furnace would have the following lengths of chambers: Preheating section, 20 ft.; firing zone, 14 ft.; cooling zone, 20 ft. Such a furnace would be rated at about 350 kw. and would produce about 4,400 lbs. of enamelled cast iron per hour. The time through the furnace for cast-iron parts would be approximately an hour, of which about 14 minutes is in the heating zone proper.

Other types of continuous furnace are occasionally employed for enamelling, including the roller hearth, and the flat conveyor type, but these applications are comparatively rare.

The following results of the operation of some of these continuous furnaces just described are taken from a Paper by Cherry and Woodson* on American practice.

A straight-through furnace in a refrigerator plant is rated at 950 kw., and is designed to give a production of 5,000 sq. ft. of 19-gauge sheet metal per hr. The conveyor speed is 8 ft. per min. and the furnace length is 90 ft., of which the firing zone is 20 ft. This means a total time through the furnace of just over 11 mins.

The return flow or horse-shoe form of furnace is the more popular, being more compact. A furnace of this type with a rating of 620 kw. had the following inside dimensions: 33 in. wide, 50 in. high, with a heating chamber 38 ft. long and the recuperative chambers 51 ft. long each. The output was 6,475 lbs. gross or 4,725 lbs. net. This works out at 11.1 lbs. of enamelled work per unit (or 15.2 lbs. of work and supports per unit). This would mean 22 lbs. for 1d. approximately. An installation on cast iron rated at 225 kw. gave a net production of 2,500 lbs. of work with an economy of 12.5 lbs. of work per kw.-hr.

Continuous *versus* Batch Furnaces

Continuous furnaces have certain obvious advantages, which include the following:—

(1) There is evidently a large reduction in the amount of labour required both for operation and supervision. A large furnace producing a ton or two tons per hr. requires an unskilled man to load the work and another to unload. In America, where the cost of labour is approximately two to two and a half times the costs in this country, this becomes a very serious factor.

(2) The thermal efficiency or economy is much higher, and from 50 to 100 per cent. more work per unit of energy is obtained. This is due to the effect of recuperation, generally lighter supports, and the minimising of door losses from a large open-mouthed furnace.

(3) The output per unit of floor space is greater, and no charging machines are necessary.

(4) All the work gets the same uniform treatment and is independent of the human element. The percentage of rejected work is generally 1 per cent. or less.

(5) The work is subjected to more gradual heating and comparatively slow cooling through insulated chambers, which obviates strains due to the difference in thermal expansion of the base metal and the enamel. It is therefore claimed, and quite rightly so, that the quality of the work is better than batch-treated material.

(6) It is conveniently adapted to a mechanised plant.

On the other hand there are certain disadvantages, including:—

(1) The thermal economy depends upon more or less continuous operation, and it would be futile to use such a furnace for a few hours a day. It is therefore not adapted to intermittent working.

(2) The capital expenditure is high, and a fairly large production must be envisaged to write this off within a reasonable time.

(3) It is not advantageous to vary the work and the temperature too frequently, although the plant would be flexible to quite some extent in the size and shape of articles treated.

It would appear that such furnaces should find an advantageous application in those shops which run a battery of batch-type furnaces but can find little use in low-production plants.

Advantages of Electric Heating

A few years ago one could have stressed many advantages of electric heating for this process not possessed by other fuels. To-day, however, fuel-fired furnaces—especially gas—have been so much improved that some of these advantages have disappeared. In the first place there is cleanliness, as compared with solid fuels and oil. Cleanliness and absence of spotting are one of the chief desiderata in enamelling. With electricity it is possible to grade the elements and put the heat exactly where it is wanted, and the heat uniformity is fixed in an electric furnace. Nobody can walk past the furnace, screw down a valve and alter the distribution of heat. The furnace can be switched on by a time switch and there is no necessity for flues.

For small furnaces the convenience and cleanliness of electric furnaces hold out a considerable appeal, but for larger batch furnaces, unless electricity is cheap, there will be no large application. Continuous furnaces electrically heated are very efficient in energy and labour, but recently the radiant-tube type of gas furnace, automatically controlled, has become a competitor of electricity and possesses some of its advantages such as cleanliness. A discussion as to the relative merits of these fuels would be instructive, for in describing electric furnaces and the results of their operation, only one side of the picture has been presented.

* World Power Conference, Stockholm, 1933.

Problems of the Users of Vitreous-Enamelled Ware

DISCUSSION IN LONDON

The Southern Section of The Institute of Vitreous Enamellers held a symposium recently on "Problems of the Users of Vitreous Enamelled Ware." Mr. W. Thomas presided, and the discussion was opened by Mr. C. A. Masterman (of the Gas Light & Coke Company). Many of his colleagues in that company were present and participated in the subsequent discussion.

VIEWS OF A USER

In the course of his remarks, MR. MASTERMAN said:—

The Gas Light & Coke Company serves an area of some 500 square miles in and near London, involving a population of about five million persons. Vitreous enamelled goods bought for distribution to its consumers probably amount in value to over £1,000,000 per annum; thus it is evident that, since it is the company's concern to ensure as far as possible that the appliances and their installation are satisfactory to the user, the quality of the vitreous enamel involved, whether on the appliances or fittings attached thereto, is important. This quality must be satisfactory not only when new, but must be such that during use over a period of years continues to be satisfactory.

In contrast to an ordinary trading concern, the utility companies have their consumers always with them; although the cooker or flue pipe or other vitreous enamelled article may have been installed five or more years previously, there is no time at which the company can afford light-heartedly to disclaim responsibility for defect or weakness in the enamel finish drawn to its attention by the user of gas whose custom, as a user of gas, it wishes to continue and increase.

The company is therefore repeatedly facing the old problem of equating capital costs against cost of subsequent defect or failure. Subsequent defect or failure can under such conditions be a very expensive business, and the gas companies naturally look for a high-quality enamel, since the appliances on which the enamel is only a small part are themselves only a means to an end—that is, the sale of gas. Thus, it might be held that an ideal quality of enamel should be specified in order to ensure that later the relatively expensive appliance is not displaced on grounds of defect and the gas consumption which that appliance represents be lost.

On the other hand, it will be familiar to enamellers that the demand for the highest quality enamel entails high costs at works, not so much in the enamel itself as in the rejection of the enamel parts which, in the finally enamelled condition, represent considerable value and often can be re-enamelled if at all only at considerable cost.

In the company's laboratories the staff has for long been struggling to establish reliable tests which shall indicate beyond doubt when the enamel quality is satisfactory for practical purposes over a prolonged period of time. It has also drawn up a code for acceptance of enamel on visual inspection, attempting, with the co-operation of makers of gas appliances expert in this matter, to give clear indication of the minor blemishes and defects which shall not be reasonable cause for rejection, and those more serious though not necessarily more visible blemishes which shall be cause for rejection.

Commercial Standards

Finally, the company has attempted to ensure that its sales staff who deal with the consumers shall understand that, in this world, nothing is perfect, and that there are blemishes and defects on enamelled finishes which must be accepted as satisfactory commercial standard and which shall not be reasonable cause for return from a consumer or for complaint to the manufacturer.

It is common experience that the customer, having bought the article—whether it be a gas cooker, motor-car, wireless set or some other alternative—may easily find some change in plans on his part which would make it convenient to throw back the goods on hire purchase to the retailer, with the excuse that the goods are defective. The vitreous enamelling is one of the commoner reasons or excuses given in these circumstances, excuses which for commercial reasons the company must do its utmost to resist in fairness to other consumers not making such complaint.

When asked to read a Paper on the subject of vitreous enamelling the author explained at once that he felt himself in no position to give information on this subject, but rather that he was urgently seeking information so as to improve his company's technique.

The subject obviously calls for a full and frank discussion, so that more satisfactory acceptance tests than those now in vogue may be indicated.

Laboratory Tests

Laboratory tests, which in some form or another have now been in use for some years are, from the company's angle, by no means satisfactory, but to stimulate subsequent discussion their form will be outlined.

In the impact test, there is a rod of standard weight hinged at one end to a base plate which is firmly set on the enamel surface. Sliding on the rod there is an adjustable standard weight carrying on its lower end a hardened steel ball. In its earlier form the rod was allowed to drop freely from the vertical to the horizontal position so that the steel ball impacted on the enamel surface. After each such fall the slide was moved 1 in. further from the hinge so that successive blows of increasing intensity were given on fresh surfaces of the enamel until visible damage to the enamel occurred. Latterly, it has been felt that more satisfactory results could perhaps be obtained by repeated blows on the same portion of the enamel surface. Nevertheless, this test has in some degree been of use.

An abrasion test is applied involving a series of powders of increasing hardness on the Mohr scale rubbed on to the enamel surface with leather under a standard weight, the point at which visible damage occurs to the enamel being taken as the criterion. Recent work has indicated that perhaps more attention than hitherto should be devoted to the size of grain of the powders.

Enamels have been subjected to chilling test, the enamel surface being raised to a predetermined temperature and then plunged into cold water and thereafter examined for crazing and other resultant defect.

A staining test has been used, although it is not felt that even yet it has reached satisfactory form, involving the contamination of the surface with caramel or with material which is baked on and thereafter cleaned off and the enamel surface subsequently examined for damage. Enamels are also examined for acid resistance by exposing a limited area to a drop of acid of standard *p*H value, the acid subsequently being titrated and change in *p*H value being accepted as criterion of attack. Finally, the enamels may be examined for lead content.

These tests, as in the visual examination itself, are quantitative only to the extent to which several observers are able to agree as to the point where visible damage has occurred, and the author looks forward to the development of much more precise methods for gauging apparent damage, whether in the definite breaking up of the enamel under impact test or breaking of surface or loss of gloss under abrasion and acid resistance tests.

Application Problems

A further problem arises in that the enamels are not all in practice subjected to the same treatment. Not only is enamel divisible into that on cast iron and/or sheet iron goods, but it is used on the linings of refrigerators, representing one set of circumstances; internally and externally on flue pipe, on the exterior of many gas water heaters and on the various parts of the majority of gas cookers. It will readily be appreciated that on the cooker the various parts receive in practice very different treatment, and very different qualities of enamel may be held to be desirable. For instance, oven linings will generally deteriorate due to heat crazing and staining from the boiling fats; the legs, bridge pieces and external panels will be subject purely to mechanical damage; the cornices are exposed to some heat, but chiefly will suffer from staining, while the hotplate bars and crown plate will reach higher temperatures and spillage to which they should be resistant, together with chilling when hot.

Some of the softer enamels will probably give the most brilliant effects when new, but will be liable to show considerable depreciation in use. On the other hand, the hardest and most heat-resisting enamels, if used for all parts of the cooker, will represent unwarranted expense. Even with an established code for testing, considerable experience and discretion is needed in the application of this code to a single gas appliance, such as a cooker, where strictly technical considerations might dictate the use of half a dozen or more enamel qualities. Not only would such quality variation represent complication at works in preparation and firing, but it would probably lead to excessive contrast in appearance between various parts of the one appliance. This would be most marked, of course, in the plain cream or colour finishes which, being most expensive, tend to go to the most critical consumers. Mottle finishes, which are used in great quantity, have the great advantage that the mottle effect tends to hide blemishes due to use even though they may be present, and a mottle cooker will look in good condition many years after the same treatment will have reduced a plain colour finish to a very shabby condition.

Acid resistance, which has been mentioned, is of importance not only as carrying with it a number of desirable qualities, but also because it represents a degree of resistance to the products of condensation, which is desirable wherever such condensation can occur, as, for instance, on the door frame of a cooker oven or internally on the flue pipe of gas water-heaters.

The author is not entirely satisfied, however, that the consuming industry is justified in omitting tests for resistance to alkaline attack, which may easily occur as a result of the general use of alkaline cleaners also containing abrasive. He is conscious, however, of the economic danger of urging a higher and higher standard of quality of a somewhat artificial kind. His company has, for instance, found itself from time to time in negotiation with manufacturers, complaining of lumps and blisters on the less conspicuous parts of gas appliances immediately adjacent to lugs or raised lettering, which after the enamelling process were ineffective or undecipherable, and constituted a much greater eyesore than the lumps or blisters of which complaint has been made.

An Ideal State

It would be a happy day if there could be established for cast-iron and sheet-iron goods after enamelling an agreed code for quality subject to quantitative test in respect of the four or five qualities which are desired in respect of finish in a vitreous enamelled article. It would be convenient to have three or four agreed qualities for resistance to acid attack, three or four qualities for resistance to heat, three or four qualities for resistance to mechanical damage, and a variety of qualities for resistance to staining. In this ideal state it would be possible to quote for any given part of a cooker or any other gas appliance or fitting a minimum quality in each category consistent with the requirements of that particular part. Thus for some parts of a cooker, resistance to mechanical damage would be the only feature of real importance, for other parts staining, and for others temperature in varying degree.

The company's specifications cover enamel finishes from the visual inspection point of view only; whereas the laboratory tests to which references have been made apply to new and selected examples as representative of the whole, the specifications standardised apply to virtually every vitreous enamelled article bought and represent the company's conception of a reasonable commercial standard of enamelling. Comment or criticism would be appreciated from the members on these specifications, which form the basis of the routine inspection of deliveries of new articles and also the basis of discussion with consumers who may be alleging dissatisfaction with the quality of enamel on enamelled articles which have been in use for some time in their own homes.

The author wishes to take this opportunity of expressing the thanks of the gas industry to those experts in vitreous enamelling who have enabled the technique to proceed so fast over the last few years, and who have been responsible for the greatly improved appearance and practicability of gas appliances now compared with those of some few years ago. It is hoped that this progress in the application of films of glass on to metal surfaces has by no means reached finality and that in addition to the provision of resistant and attractively coloured finishes one may look forward to a time when texture may receive more attention. It is assumed that brilliant gloss of the appropriate colour shade is ideal for all requirements. That this is a limited ambition is shown by the varying textures obtained and greatly appreciated in paintwork, to an even greater extent in brick and wood, and to a still greater extent in textiles. The day may come when some degree of attractive variation in texture may, as in other finishes, be available in vitreous enamel, which would greatly extend the scope of this extremely useful finish.

DISCUSSION

User Criticism

MR. S. F. DUNKLEY (Gas Light & Coke Company) said that conceivably some of those engaged in the vitreous enamelling industry would be amazed by the trifling complaints with which the gas undertakers had to deal, involving the exchange of expensive appliances in some cases. By reason of his close contact with many of the manufacturers, he realised some of their difficulties, and he congratulated them upon the very rapid improvement in general quality during the last few years. He emphasised the need for some national code of rules or specification which would put a maximum or a limit to minor imperfections which must of necessity arise in commercial enamelled articles, and he asked whether there was any movement in the direction of producing such a national standard. Some tests were necessary, not only from the point of view of differentiating between different qualities of enamel, but also to provide a basis upon which to work to produce a still better quality of enamel.

Control Tests

In the early days of the use of vitreous enamelled appliances, the Gas Light & Coke Company found it necessary to institute certain tests, and in the course of applying those tests he had realised their weaknesses. The vitreous enamellers could help a great deal to improve those tests, and if necessary a British Standards Committee could develop tests to be applied to the finished products.

Continuing, Mr. Dunkley wondered whether, in the case of cast-iron parts, the selection of the most suitable type and composition of iron used did not offer the answer to considerably reducing or eliminating the majority of minor defects. He believed that it was the universal practice to use castings of grey iron for enamelling (*i.e.*, an iron containing large quantities of carbon in the graphitic form), but he had wondered whether an iron machinable but more approaching a white iron would not be better for the purpose.

Another question was whether steps had been taken nationally to standardise colour oxides. This was important so far as the gas industry was concerned since small variations in colour gave considerable difficulty in the renovation and

repair of vitreous enamelled appliances. The policy of selective assembly had to be adopted by the gas industry and, he believed, by many of the manufacturers.

Packing

The Gas Light & Coke Company had observed that by far the largest number of defects were in the form of chipping, due to lack of adherence and lack of toughness of the enamel. Had the manufacturers of the appliances ever considered the problem of more suitable packing of appliances, because it had occurred to him and his colleagues that, the more carefully they were packed, the greater the amount of paper, shavings, etc., placed around the appliances in the packing cases, the less likely were they to be handled carefully. The more the contents of a package were concealed the more would the package be knocked about. The enamelling industry might consider the use of open-framework wooden crates, specially designed for particular appliances, and in which corners, etc., could be protected by rubber; such crates would be returnable to the manufacturers by the purchasers of the appliances.

Replying to Mr. Masterman on the question of texture, he felt that gloss was one of the most important aspects of vitreous enamel, and it certainly facilitated cleaning; it had been observed, in the examination of very large quantities of returned enamelled appliances, that those which had the highest gloss initially generally lasted best over a period of years.

Matching and Packing

MR. B. B. KENT expressed agreement with the remarks of Mr. Dunkley. With regard to colour, he said that at the moment over 50 different mottles had to be matched in the works, and he asked if the cooker makers and enamellers could co-operate to arrive at standards for mottles and colours.

It was his experience also that the best policy was to pack crates in such a way that the transport companies could see what was inside them. An appliance wrapped up and labelled "do not drop" was not necessarily immune from bad handling, but if the enamelware could be seen it would receive more favourable treatment.

Matt Finishes

MR. W. MAVOR pointed out that there were various grades of acid-resisting enamels, and it would be of material assistance to suppliers to know the degree of resistance to acids, to chipping, and so on, required by the users. They would like very much to co-operate in establishing a standard or specification for enamels, and the tests they should withstand. With regard to textures, there were vitreous enamels with matt finishes, but to his knowledge they had been used only in the architectural field.

MR. J. BARRY added that enamels with matt finishes were used on the destination boards on the underground railways. Passengers could read those boards without being dazzled by the light, which would otherwise be reflected if they were glossy.

Durability Studied

MR. C. P. STONE, commenting on the references made to periods of five years and 10 years as the life of an enamelled cooker, said that when in America recently he had discussed with various people the period during which such enamelled ware should remain in use, and they had stated that they expected it to be on the scrap heap before a period of five years had expired, if they were to remain in business. The long life expected of apparatus in this country, however, had brought about an intensive study of durability. He was one of those responsible for the application of sponge mottle to cast iron, which he still considered to be the strongest enamel from the point of view of wear and tear, provided it was correctly produced; he emphasised, however, that its production involved three firings, and that two would be insufficient. The principle was that it must have thin coats, which gave strength. If one applied a heavy coat and mottled on top of that, and then cut through the enamel, it would be often found that it had not been fired right through in heavy places.

Acid-Resisting Enamel

When he had introduced acid-proof finishing on cast iron ten years ago, the scrap was more prominent than the good material at the final inspection, yet by assuring proper control in the works, and co-operation between the foundry and the enamelling department, the scrap was reduced to reasonable proportions. By 1934, a very high percentage of good material was produced. Every morning there had been meetings of representatives of the foundry and the enamelling department to discuss defects—and each day further tests would be made to eliminate them by both departments.

Quality and durability came almost under the same heading, because if there were to be a standard of quality, there must also be a standard of durability. Good quality resulted from good shop practice, and one could regard shop practice as being responsible for the majority of one's trouble, such as discoloration, wiping of edges, crazing, hair-lining, chipping, etc.

Commenting on a reference in the Gas Light & Coke Company's code of rules to not more than four enamel coats being permissible, he said that if there were four coats of enamel on a plate, the enamel would be thicker than the plate, and it was bound to come off in lumps.

Impact Tests

He supposed that the impact test referred to applied to enamelled cast iron; if the blow were applied to enamelled sheet iron, the sheet would bend away from the blow and the sheet iron would be leaving the enamel, rather than the enamel leaving the sheet iron. With enamelled cast iron, the failure occurred by crushing in the majority of cases, owing to mechanical strength of casting. The highest impact figures were obtained on good-quality three-coat sponge mottle.

Enamels could be placed in any one of four categories, depending upon the way in which they were treated in production; according to whether shop practice was good or bad, an enamel which might have been in category No. 4 could be in category one, or an enamel which should have been in category No. 1 would be in category No. 4. The enamel might not have been properly ground, the casting or sheet might not have been of the highest quality, or might not have been properly cleaned, or many other things due to bad shop practice.

Expressing agreement with Mr. Dunkley's view that enamels with good gloss withstood wear and tear for the longest period, he said that matt finishes, or even semi-gloss finishes, seemed to provide means for holding dirt; if one drew a lead pencil over them, there was difficulty in getting rid of the mark.

He maintained that satisfactory results could be achieved, given good technique, whether one used the finest ingot iron or a No. 3 or No. 4 grade of steel, *i.e.*, containing up to 0.09 per cent. of carbon. It all depended on the number of firings to which they were subjected, the steel would not stand the same amount of firing as the ingot iron and give similar results, but good results with low-grade steel could be obtained in practice.

Colour

Oxides could not remain of identically the same shade of colour all the year round; but if the control within the plant were adequate, no mill of enamel should be passed through the shops for production unless it had passed the master colour. If there were a little over-firing in the furnace, the colour might be deeper in shade than the colour which it was intended to produce. There were many difficulties to be overcome in the enamelling shop, but they could be overcome.

Pleading for proper inspection at every stage, he said that after the cast iron was annealed, it should be examined for cracks, and both cast and sheet iron should be inspected after cleaning. It should be properly examined after each enamel firing operation. Shops which worked on those lines usually produced ware of good quality, consistent colour and durability.

Commenting on the reference to white iron, he said that the enamellers could deal satisfactorily with white iron or with castings classified as malleable, but he was afraid that the cost would be rather great.

Colour Matching

MR. MASTERMAN felt that if precision in colour matching were driven too far it would raise prices unnecessarily. If someone bought a vitreous enamelled cooker or fire in which the various parts matched, it seemed a pity to scrap all other parts which had not an exactly similar finish if they could be absorbed in another cooker or fire which was not likely to sit side by side with the first.

In his reference to matt finish, he had had in mind the possibility of producing vitreous enamel the appearance of which gave a greater sense of depth, such as was obtained in textile finishes. That might be impossible; but gloss finish *per se* was so much less popular on other products, and he had wondered whether vitreous enamel might be produced with a finish which was rather different from the present-day finishes.

Suggesting that something might be done at the foundry end to clean up the castings, he said that very often the foundrymen put names, lugs and bits and pieces on the castings; the names became illegible, the lugs ineffective and much more objectionable in appearance than the enamel lumps of which complaint was normally made.

He asked for comments on the possibilities of the use of a transparent glaze, in order to get an effect on the underlying metal. For instance, he would like to know what a burnished steel would look like if glazed over with an entirely transparent enamel.

The quality of enamelled ware was such that, on the average, any hired gas appliance would be returned in about five years and would require to be renovated before being sent out for re-use. If the enamel quality were such that the greater part of the appliance could be merely cleaned and would then be sufficiently near to its original condition to be sent out for a second period of life, instead of having to be scrapped and replaced, it would help the gas undertakers; although he did not know whether it would help the makers of the appliances!

Thickness Gauging

MR. G. H. ABBOTT asked whether the Gas Light & Coke Company used a thickness gauge to measure the thickness of the enamel, as an indication of its quality.

MR. DUNKLEY said they had not done so up to the moment.

MR. W. MAVOR referred to Canadian practice, in which the inspector applied a thickness gauge to all the enamelled sheet metal parts; if of more than a given thickness, they were rejected.

Current Testing Situation

MR. E. W. B. DUNNING (Gas Light & Coke Company) recalled that the annual conference Paper on "Scientific Aids to Control in Vitreous Enamelling," by Mr. J. G. Pearce and Dr. G. T. O. Martin had discussed a large number of tests, and he asked which of those various tests had been decided upon as being the most satisfactory. One could divide the methods of test into types. There were tests which would reproduce the conditions to which enamelled ware was subjected in service, such as trying to chip a piece off or applying acid fruit juices. Then

there were tests such as thickness measurements by gauges, which might tell the enameller whether two or three coats of enamel had been applied, but which did not indicate directly whether or not the enamel would chip off.

For measuring gloss, he asked whether the photo-electric gloss-meter or a test of the reflectance of the light from the surface provided the more suitable test. He wondered whether that sort of test should not be applied to the measurement of acid resistance, because by measuring the stain on the surface one was measuring what the user of the appliance saw when a stain occurred on the enamel and became filled with dirt, and showed up to an increasing extent.

With regard to hardness tests with various powders, he had found that grinding to different degrees of fineness affected the actual test. He would like to know what particular degree of fineness was recommended, or whether some scratch test could be used, so that one could determine the relationship of the hardness to the various cleaning powders that were available for cleaning enamel.

The alkali test was of great interest to the gas industry, having regard to the use of alkaline materials for cleaning enamelled surfaces. When he discussed the matter with manufacturers of enamel or frit, they put forward various cleaning powders which were supposed to be very successful, but he had not found one of them near the efficiency of ordinary caustic jelly for removing the grease and burnt-on fat from the interiors of cookers.

MR. G. C. HOLLIDAY (Gas Light & Coke Company), commenting on Mr. Stone's remarks concerning the life of American cookers, said that many people would not like to regard American appliances generally as an ideal. British appliances were of higher standard, and his company expected the same high standard in the quality of the enamel finishes. If the meeting could agree on the tests which the manufacturers should apply before the appliances were delivered to the gas undertakings, it would have been a great success.

Drop Tests

MR. W. MAVOR referred to a specification he had drawn up, and said that the Hunter reflectometer would give the best test of the opacity of enamel. The chipping or impact test he used was similar to that described by Mr. Masterman. It had been suggested that it was better that the weight which was dropped should have a blunt rather than a sharp point. The method of dropping the weight on different spots from different heights had been compared with that of dropping the weight always from the same height, and he and his colleagues had decided that the method of dropping the weight from different heights gave the better test.

Caustic Soda Cleaning

MR. B. B. KENT commented that he did not know anything which would clean enamel so quickly as caustic, nor did he know of anything which destroyed it so quickly. He could remove the enamel from a gas cooker entirely within 15 seconds by the use of caustic soda, and the continued use of caustic soda by users of enamelled ware would remove the enamel.

The manufacturers of enamelled ware would like to ask the gas companies to forget about the number of coats of enamel and merely to specify the thickness of enamel required. The enamellers could apply 15 coats of enamel to an article and give quite a thin cover coat; on the other hand, they could apply only one coat, which would fall off immediately the article left the works. He considered the application of four coats to be undesirable, and he asked Mr. Dunkley how much enamel he wanted on a stove.

MR. DUNKLEY replied that, although he was supposed to be at the bottom of the Gas Light & Coke Company's code of rules for acceptance or rejection of vitreous enamel finishes on cast iron, it had been prepared more or less by some 30 vitreous enamel firms in this country, and the problem of thickness had been discussed probably more than any other. The code stated that not more than four enamel coats would be permissible, but that the third and fourth coats, if required, should be kept as thin as practicable, especially in corners. He believed such words were included primarily because the weights might otherwise have been too great. The enamellers would be annoyed if the Gas Company wanted to scrap an interior lining of a refrigerator in which the grip coat was a little heavy, despite the fact that there were two coats on it. The interior lining of a refrigerator was not subjected to heat or much mechanical abuse, and he believed that was the reason for the wording adopted. From what he had learned from manufacturers, he agreed that the finer the coat of mottled enamel, the more durable it was.

MR. KENT suggested that refrigerator linings represented a small item as compared with, say, splash plates and crown plates. If one put four coats on a splash plate, it would soon come back again. He asked what thickness of enamel the gas company would like on a crown plate or a splash plate.

MR. DUNKLEY said it would be a good thing to re-circularise the code among vitreous enamel experts, and ask them to modify it; it might represent the start of a national code. In America he had seen apparently perfect plates of white enamel rejected because they were sprayed too thickly. They were table tops, and would have chipped after being used for a week or two.

Measuring Enamel Thickness

MR. J. BARRY said that his works put on not more than five thousandths of an inch for a primary, and not more than ten thousandths of an inch for the cover coat.

MR. KENT remarked that he had seen enamel measured in sixteenths of an inch rather than in thousandths.

MR. STONE suggested that it could be expressed in weight per sq. ft.

MR. BARRY pointed out that it was difficult to measure the weight of enamel on a finished appliance. In sheet iron, for example, the weight of a particular gauge varied enormously.

MR. STONE replied that there was a great deal of difficulty in assessing it at 5, 15 or 20 thousandths of an inch.

MR. DUNKLEY asked if the enamellers would permit the quality and thickness all over the article to be tested, and MR. KENT replied that he would.

MR. MASTERMAN pointed out that the more the specification was complicated, the greater would be the price of the article, but MR. KENT said the gas company would save more in the long run, because there would be less rejection of appliances after having been in use for a week or two.

MR. DUNNING asked if there were statistics to show the relation between the number of defective articles returned and the thickness of the enamel applied.

MR. KENT said that 99 per cent. of the articles returned by reason of chipping had chipped because the thickness of the enamel was too great, and asked the extent to which the thickness was too great, he added that some of the articles had three times the amount of enamel they should have.

Misuse of Enamel

MR. W. E. BENTON commented that the meeting provided a good opportunity to raise the question of the mis-use of enamel. Every material had its proper sphere of application, and when Mr. Dunkley revised his code of acceptance he might give some guidance as to the articles which should never be enamelled at all. Vitreous enamel had a definite sphere of usefulness in connection with domestic appliances; but it was not an *ideal* material. The best way to create confidence in vitreous enamelling was to avoid enamelling things which were not suitable for enamelling.

Developing that point, he said the history of ceramics was full of cases where the limitations of a material had been recognised. In the thirteenth century the Chinese, slowly perfecting their early porcelains, were beset with the difficulty of glazing the rims and edges of their plates. They had recognised that their material was unsuitable for that purpose, and therefore, they had bound the plates with fine bands of copper. The result was that the plates could be seen to-day in perfect condition. In the seventeenth and eighteenth centuries the Bristol delft potters had been faced with the same problem; their tin-white glaze would not hold to the edges of their earthenware bodies. But they had ignored the point, with the result that nearly all their plates had chipped at the edges. The Staffordshire stoneware potters were wiser, and Adams, Turner and Wedgewood had bound the tops of many of their jugs with silver rims, because the ware otherwise was very good, and they had wanted it to last. In the eighteenth century the enamellers of Battersea, Bilston, and Birmingham had also recognised that they could never make a clean job of the edge of a white enamelled plate. They had bound every single piece in a delicate copper frame, usually chased and gilt; and they were in good condition to-day.

He did not suggest that all enamelled domestic goods should be framed, but he did suggest that there were certain things which should not be enamelled. Some companies had asked for enamelled oven-grids, but his own firm had considered it bad practice to supply them. It would be a good thing to have the guidance of some authoritative body as to the things which were not within the province of vitreous enamellers. Quite recently, one of the trade enamellers had produced an enamelled cake tray. The appliance maker was between the trade enameller and the public and had to give reasons why he declined to put enamelled cake trays in his cookers. There was no case for an enamelled cake tray at all.

Enamel Composition

The standard of acid resistance necessary to withstand the products of combustion from ordinary coal gas was very high indeed. One could say that enamel should be able to withstand the action of 10 per cent. oxalic acid for half an hour; it would then withstand the action of the products of combustion. His experience was that the effect upon enamelled steel oven linings depended very much upon the amount of sulphur in the gas; some gas undertakings supplied gas in which the sulphur content was admittedly very high, and more trouble arose in the area supplied by those undertakings than in any others. There had been great improvements through the introduction of titanium enamels, and there was a number of colours of high acid-resistance, but sales were not restricted to those. There was a fashion for black and white, regardless of the fact that there was still no good acid-resisting black. Enamellers were not combating the public demand for black and white by indicating that position. Appliance makers were forced to supply some colours which had a far lower standard of resistance to acid than had some of the others.

He would like to know who first introduced the enamelled grill pan. Surely a grill pan was totally unsuitable for enamelling, and an enamelled grill pan could not bring the industry into credit with the public at all, particularly when salesmen asked for the supply of very light coloured thick enamel. Enamellers were going back to thin black enamel, which was much more suitable, but even so the grill pan was not suitable for the application of enamel at all.

Another problem was that of hardness, and he urged that enamel was not suitable for any bearing surface, such as a hinge; enamel should

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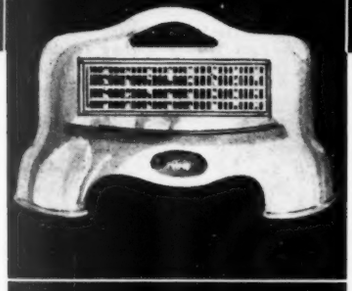

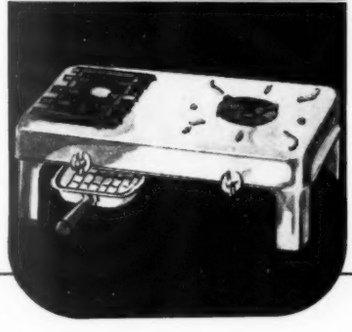

Colour is a "best-seller."

The modern trend in all domestic utilities is for more and more colour—colour to match decorative schemes, colour to give sales appeal, colour for itself alone, in every kind of household appliance from cookers to sinks.

The manufacturer of vitreous enamelled ware who wishes to be on top of the trend will make his wares attractive by full use of the comprehensive range of Blythe coloured enamels and colouring oxides for cast-iron.

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13

not be used on parts which were subjected to weight.

Then there were the problems of elasticity and the reaction of the enamel to repeated heating and cooling, and that was particularly noticeable in the case of top bars. In some cookers there was a tendency, which he regarded as a particular evil, to mix parts which were black japanned with parts which were vitreous enamelled. The public was not always made aware of the difference. Some fittings were of black japan finish because it was extremely difficult to enamel them. But the extent to which paint and enamel should be mixed ought to be defined.

MR. C. P. STONE said it was seldom that a grill pan on an electric cooker failed, and he wondered whether the griller on a gas cooker was more fierce than on an electric cooker. A point of great importance was that the grill pan had always a big air space beneath it, so that the bottom of the pan could expand away from the heat. In case that should worry any of the enamellers, he suggested making the grill pan of thin cast iron. In that connection he said that the best bacon frier ever made was a cast-iron enamelled frying pan. Whereas sheet steel would move to and fro, cast iron was rigid.

Cleaning Troubles

MR. DUNNING pointed out that only about 10 per cent. of the Gas Light & Coke Company's consumers earned as much as £5 per week, and probably less than 5 per cent. had any domestic help. The consumers who bought enamelled cookers were generally the poorer people, who lived in their kitchens and, therefore, liked the cooker to look smart and neat. On an enamelled cooker there was less work to do. The problem of cleaning the interior was very important. It was useless to say that users of cookers must not use caustic jelly for cleaning; they would continue to use it unless some better cleaning material could be produced. Failing that it was necessary to produce an enamel which would withstand the action of such materials.

MR. STONE said that he was prepared to make an enamel to withstand the action of proprietary cleaners of the caustic soap type. They were used, of course, in the cold condition. The majority of acid-resisting enamels made to-day, he said, would withstand the action of a 4 or 5 per cent. solution of cold caustic soda, in that they would not lose their lustre. Inasmuch as the caustic soap types of cleaners were used in the cold, they should not attack. It was the warming that caused trouble.

Toasting Grids

MR. MASTERMAN, commenting on the remarks of Mr. Benton, said that burners and hotplate bars seemed to stand up in vitreous enamel better than in anything else, and he asked whether, even if they were imperfect, it was not better to use the best medium that could be found.

MR. BENTON said that for burners it was a good thing, and the point was to find the best enamel to use.

MR. KENT said that it should be acid-resisting.

MR. STONE added that it must also be heat-resisting; very few of the acid-resisting enamels were also heat-proof.

MR. BENTON said the point of his remarks was that a body representative of the whole trade should surely be capable of indicating the things which should and should not be enamelled. Cookers were ordered in various finishes, but a definition backed by The Institute of Vitreous Enamellers and by the Gas Light and Coke Company would carry weight.

MR. KENT said that enamellers had rightly refused to enamel the grill on a cooker, their reason being that they hated the thought of people crunching pieces of enamel in their toast.

MR. BENTON said that if there were some definition, and one producer refused to enamel a certain part, he would have the satisfaction of knowing that other producers would follow suit.

MR. STONE said he had proved more or less that the ability of enamels on burners and grid bars to resist the conditions was to an extent dependent on colour. Some people would demand a grey mottled top bar and burner, but others demanded black. Some years ago he had found that the colour which lasted longest under those conditions was brown. The brown was nearer the colour of the stains from the flame. White or silver grey would turn brown, and black would turn white.

MR. DUNNING referred to tests which had shown that black stood up much better than brown. He believed that was due largely to the design of the parts, so that the passage of the products of combustion was controlled. It had very little to do with the colour.

MR. STONE replied that the Gas Light & Coke Company had carried out many tests on brown burners, etc., between 1932 and 1935, and had confirmed his own theories and experiments.

Vote of Thanks

MR. KENT, proposing a vote of thanks to Mr. Masterman for having opened the discussion, said that the occasion was unique, in that the industry's "public customer No. 1" had taken the trouble to tell the enamellers what they were doing wrong and what he would like them to do. He hoped that at a later date some standard would be available.

MR. STONE, seconding, said that necessarily the customer must have regard to costs. One could only hope that some of the seed dropped by Mr. Masterman would fall on fertile soil, to the ultimate benefit of the makers and users of enamelled apparatus.

MR. MASTERMAN, in his response, said that if the meeting resulted in helping forward the establishment of standards, he and his colleagues would have been more than repaid for any effort they had made. If they tried to create standards themselves as users, there would inevitably be difficulties; they would prefer that the initiative came from the enamelling industry.

Book Review

Symposium on Impact Testing. Published by the American Society for Testing Materials, 260, South Broad Street, Philadelphia, Pa., U.S.A. Price $1.25.

The Symposium on Impact Testing, held at the 1938 annual meeting of the American Society for Testing Materials, concentrated on two of the most important phases of the subject, first, the present fields of commercial use for the impact test, with particular reference to places where it gives necessary information not supplied by static tests, and, second, the basic theory of the test. Nine extensive technical Papers and discussions are included in the 170-page published report.

Utility and non-standard impact testing, problems in the field of plastics, practical application of the notched-bar impact test, and use of the Charpy test as a method of evaluating toughness adjacent to welds are covered in separate Papers, followed by data on stress-strain relations under tension impact loading and a discussion of the theory of impact testing, involving the influence of temperature, velocity of deformation and form and size of specimen on work of deformation. There are some general considerations on the impact testing problems; then a review of the literature on impact testing of welded joints is given, and finally a *résumé* of notched-bar testing and impact testing. The publication contains a great deal of valuable information and data in the form of tables and charts.

Publication Received

Report on the Conditions and Prospects of United Kingdom Trade in India, 1937-38. By Sir Thomas M. Ainscough, C.B.E., H.M. Senior Trade Commissioner in India. Published by H.M. Stationery Office, York House, Kingsway, London, W.C.2. Price 4s. 6d., plus postage.

The utility of much of this Report is impaired by the fact that a new United Kingdom-India trade agreement is being negotiated, and its consummation may profoundly affect the existing conditions, so that it seems useless to make deductions from the Report as to future business between the two States. Moreover, the separation of Burma from India makes many comparisons difficult.

There seems to be some recognition of the fact that the import duties have been set at too high a level, with the result that the revenue yield has been sinking and international trading has been retarded. On the other hand, there is a spirit of economic nationalism abroad, and there is some talk about the creation of industries for manufacturing electrical machinery, motor vehicles, sewing machines, bicycles and so forth.

It is interesting to note in this connection that the Indian Stores Department gives every encouragement to this activity, and the case of malleable castings is worth quoting: "In the course of inspection, advice was given to a local foundry in respect to the preparation of special moulds and cores, annealing and testing in connection with malleable cast-iron vacuum-brake and signal components manufactured by them. As a result, their products have attained a high standard and now compare favourably with imported articles both in quality and finish. The development of this industry has brought about a considerable reduction in the imports of their castings."

The imports of cast-iron pipes and fittings are practically all of United Kingdom origin and have remained stationary at about 1,426 tons. The position as to the importation of vitreous-enamelled hardware is not by any means so satisfactory. Japan supplies 60 per cent., Czecho-Slovakia 13, the United Kingdom 9, Sweden 6 and Germany 5 per cent. The U.K. trade is remaining stationary, whilst that of Sweden is expanding. The Wolverhampton product is stated to be too durable and too expensive for the cheap bazaar trade. The export of stoves to India is declining. The publication of the Indo-British trade agreement will be awaited with a good deal of interest by many sections of the foundry industry.

Record Aluminium Consumption in U.K.

According to the Aluminium Information Bureau, the estimated consumption of aluminium in the United Kingdom in 1938 reached a new record of approximately 65,000 tons, showing an increase of about 35 per cent. over the consumption in 1937 and of 88 per cent. over the figure for 1936. Home production of aluminium is also increasing, as is indicated by the fact that the imports of bauxite in 1938, at 248,930 tons, were 13½ per cent. above the imports in 1937.

About 80 per cent. of Britain's supplies of aluminium in 1938 were imported as metal, the bulk of the remainder being produced from imported bauxite. Out of the 46,254 tons of aluminium imported in ingots, blocks, slabs, etc., in 1938, Canada supplied 30,414 tons, Switzerland 9,546 tons, and Norway 5,348 tons. The total imports in 1938 of aluminium in all forms, amounting to 52,002 tons, were 40 per cent. higher than in 1937.

Exports of aluminium from the United Kingdom tend to decrease, the total exports for 1938 being 6,326 tons, against 10,191 tons in 1937 and 6,780 tons in 1936.

CLEAN IRON
SAVES COKE IN THE CUPOLA

The cleaner iron given by Workington Machine Cast Process (free from sand fused to the surface) saves fuel in the cupola. A foundry which used Machine Cast Iron reports the following results:

- **Coke consumption decreased by 20%**
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Trade Talk

THE KING is to visit the British Industries Fair at Birmingham on March 1. The Fair opens on February 20 and closes on March 3.

WALTER MACFARLANE & COMPANY, LIMITED, ironfounders, have received permission from Glasgow Dean of Guild Court to carry out a scheme of additions and alterations to the Saracen Foundry, Glasgow.

SPEAKING AT a social function in Falkirk last week, Mr. George Scotland, managing director of the Falkirk Iron Company, and chairman of the National Light Castings Ironfounders' Federation, said that, during 1938, 17,000 tons of cast-iron builders' goods were displaced by substitute materials.

HEAT & AIR SYSTEMS, LIMITED, of 172, Buckingham Palace Road, London, S.W.1, announce that after April 17 next they will not be restricted to the use of U.S.A. refrigeration equipment in their design of air-conditioning plants, their agreement with the Westinghouse Electric International Company of New York being terminated on that date.

CLIFFORD CHRISTOPHERSON & COMPANY, LIMITED, have by amicable arrangement relinquished their interest in the distribution of the "Three Elephant" brand boron products. Mr. W. J. Hatchley, who managed their borax department for many years, has resigned his directorship, to become managing director of Borax & Chemicals, Limited, of Kings Bourne House, High Holborn, London, W.C.1. This new company will take over the business in "Three Elephant" borax—boric acid previously handled by Clifford Christopherson & Company.

PROVISIONAL returns for the production of iron and steel in Poland in 1938 indicate that pig-iron output was 877,811 metric tons, against 724,296 tons in 1937, steel production 1,442,912 tons against 1,450,939 tons, the output of rolled products 1,077,502 tons against 1,043,373 tons, and that of tubes 79,311 tons against 95,970 tons. If the works in the Olsa region ceded to Poland by Czecho-Slovakia last October are included, total production included: Pig-iron, 966,416 tons; steel ingots and castings, 1,555,036 tons; rolled products, 1,164,539 tons, and tubes, 85,488 tons. Production figures for December were substantially lower than in the previous November and in December, 1937. The transfer of the Osla district brought the large Hahn pipe works at Oderberg to Poland; these works consist of steel and sheet rolling mills, a large pipe foundry, and extensive blast-furnace and steel-making plant. To make them thoroughly Polish, the Polish Government has appointed a commissioner to take over the control of the works, whose first duty will be to start up the plant and raise production to its previous levels, as since the date of cession the works have been idle. The Bankowa Steelworks, a subsidiary of the French Schneider-Le Creusot concern, report a new profit of 6,790,000 fcs. for the year to June 30 last, as against 4,290,000 fcs. in the previous year, depreciation being 16,780,000 fcs. and 5,590,000 fcs. in the two periods respectively. Dividends of 25 fcs. per founder share and 12.50 fcs. per preference share have been declared on a share capital of 48,500,000 fcs., as against a dividend of 12.50 fcs. per founder share in 1936-37. Trade in the year under review was much better than in 1936-37, private orders showing an advance of 37 per cent., State orders being almost doubled, and deliveries to subsidiaries being 25 per cent. greater than in the previous year.

Personal

MR. FRANK M. ROBBINS has been elected President of the Steel Founders' Society of America. He is president of the Ross-Meehan Foundries of Chattanooga, Tenn.

THE MARRIAGE, on Tuesday of last week, of Mr. D. H. Wood to Miss Irene Hilda Boston, was a social event of great interest to the foundry trade in Birmingham. Mr. Wood is widely known as managing director of the Constructional Engineering Company, Limited, and for many years has been a prominent member of the Institute of British Foundrymen. The ceremony took place at St. Nicholas' Parish Church, King's Norton. Mr. F. J. Hemming was best man. Among the company present were Mr. L. W. Bolton (British Cast Iron Research Association, and President of the Birmingham Branch, I.B.F.), Mr. C. W. Bigg (Past-President of the Institute), Mr. W. E. Harper (Dudley Foundry Company, Limited), Mr. R. J. Rogers (Parkinson Stove Company, Limited), Mr. F. J. Cook (British Cast Iron Research Association), Mr. H. J. Roe (Past-President, Birmingham Branch, I.B.F.), Mr. E. D. Brown and Mr. G. W. Brown (Austin Motor Company). Following the ceremony there was a reception at the Botanical Gardens, Edgbaston, and Mr. and Mrs. Wood afterwards left for a honeymoon abroad. At night the staff and employees of the Constructional Engineering Company were entertained at a theatre-supper party.

Obituary

MR. JOHN WILLIAMSON, who held the position of cashier with the Burnbank Foundry Company, Limited, Falkirk, for 30 years, retiring last year, died in his 68th year on Thursday last.

MR. JAMES HOOD, who died at Saltcoats recently, had been 42 years in the service of the North British Locomotive Company, Limited, Glasgow, and had held the position of foundry manager.

WE REGRET to announce the death of Dr. Albert Sauveur, Emeritus Professor of Metallurgy at Harvard University, Cambridge, Massachusetts, U.S.A. He was born in Belgium 79 years ago, and studied at the University of Liége. He had many years of works experience before receiving his University appointment. Dr. Sauveur was attached to the French Ministry of Munitions during the war as a metallurgical expert. His contributions to science and industry were recognised in this country in 1924 by the award of the Bessemer Medal of the Iron and Steel Institute. His position as a leader of metallurgical thought in the United States was universally recognised.

Forthcoming Events

FEBRUARY 9.

Institute of Welding (Liverpool Branch):—"Resurfacing or Reclaiming Worn Parts, and Hard-Surfacing." Paper by C. G. Bainbridge, at City Technical College, Liverpool, at 7.30 p.m.

FEBRUARY 10.

Institute of Welding (Midlands Branch):—"Welding of Non-Ferrous Metals," Paper by H. W. G. Hignett, at James Watt Memorial Institute, Birmingham, at 7.30 p.m.

Institute of British Foundrymen

FEBRUARY 11.

East Midlands Branch:—"More About Synthetic Sands." Paper by A. Tipper, at Loughborough College, at 6 p.m.

Scottish Branch:—"Melting Practice in a Large Engineering Iron Foundry." Paper by W. W. Braidwood, at Royal Technical College, Glasgow, at 4 p.m.

West Riding of Yorkshire Branch:—"Alloy Cast Iron," Paper by H. A. MacColl, at Technical College, Bradford, at 6.30 p.m.

The Institute of Vitreous Enamellers

FEBRUARY 9.

Southern Section:—"Investigation and Modern Ideas of Enamel Control," Paper by G. H. Abbott, at Charing Cross Hotel, London, at 8 p.m.

TENDER

MIDDLESEX COUNTY COUNCIL.

TENDERS FOR FIREBARS AND FURNACE CASTINGS (TWELVE MONTHS).

THE Middlesex County Council invites Tenders for the supply of the above goods or materials for the period stated from April 1, 1939, to its several hospitals, institutions, sanatoria, children's homes, offices, etc.

Forms of Tender (upon which only Tenders will be considered), and Conditions of Contract, may be obtained on application to the Director of Public Assistance, "P.4.," 3, Central Buildings (Fourth Floor), Matthew Parker Street, Westminster, S.W.1, accompanied by a stamped addressed foolscap envelope.

Sealed Tenders, marked "Tender for Firebars," must be delivered at or before 11 a.m. on Wednesday, February 22, 1939, addressed to "The Clerk of the Middlesex County Council, Guildhall, Westminster, S.W.1."

The Council does not bind itself to accept the lowest or any Tender, and reserves the right to accept any Tender or part only.

Estimated quantities required are stated in the Form of Tender, and tenderers may tender to supply all or any one or more of the Establishments concerned.

C. W. RADCLIFFE,
Clerk of the County Council.

Guildhall,
Westminster.
January, 1939.

SITUATIONS VACANT AND WANTED—
Continued from page 18

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

ASSISTANT STEEL FOUNDRY MANAGER, Works Manager or Foundry Technician. Young man requires position in one of these capacities. Sound practical experience in steel foundry and in laboratories. Has had full charge of steel manufacture of steel castings by open-hearth and tropenas processes. Conversant with all phases of steel foundry practice, practical and technical control. (346)

FOUNDRYMAN requires situation. Competent to control cupolas, metal mixtures and sand plant on modern lines. Experienced continuous casting and general, light castings and engineering, coreshop, etc. (347)

FOUNDRY FOREMAN desires re-engagement, considerable experience in full charge, machine tool, hydraulic, engine and valve castings. All types of foundry practice. Experienced on high-duty irons. (348)

PATENTS—*Continued from page 18*

THE Proprietor of British Patent No. 386,159 is prepared to sell the patent or to license British manufacturers to work thereunder. It relates to machines for casting metals.—Address: BOULT, WADE & TENNANT, 112, Hatton Garden, London, E.C.1.

THE Proprietor of the Patent No. 283,891 for "Improvements in or relating to Mechanical Time Fuses for Projectiles," is desirous of entering into arrangements by way of licence and otherwise, on reasonable terms, for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed in the first instance to: HASELTINE LAKE & Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2.

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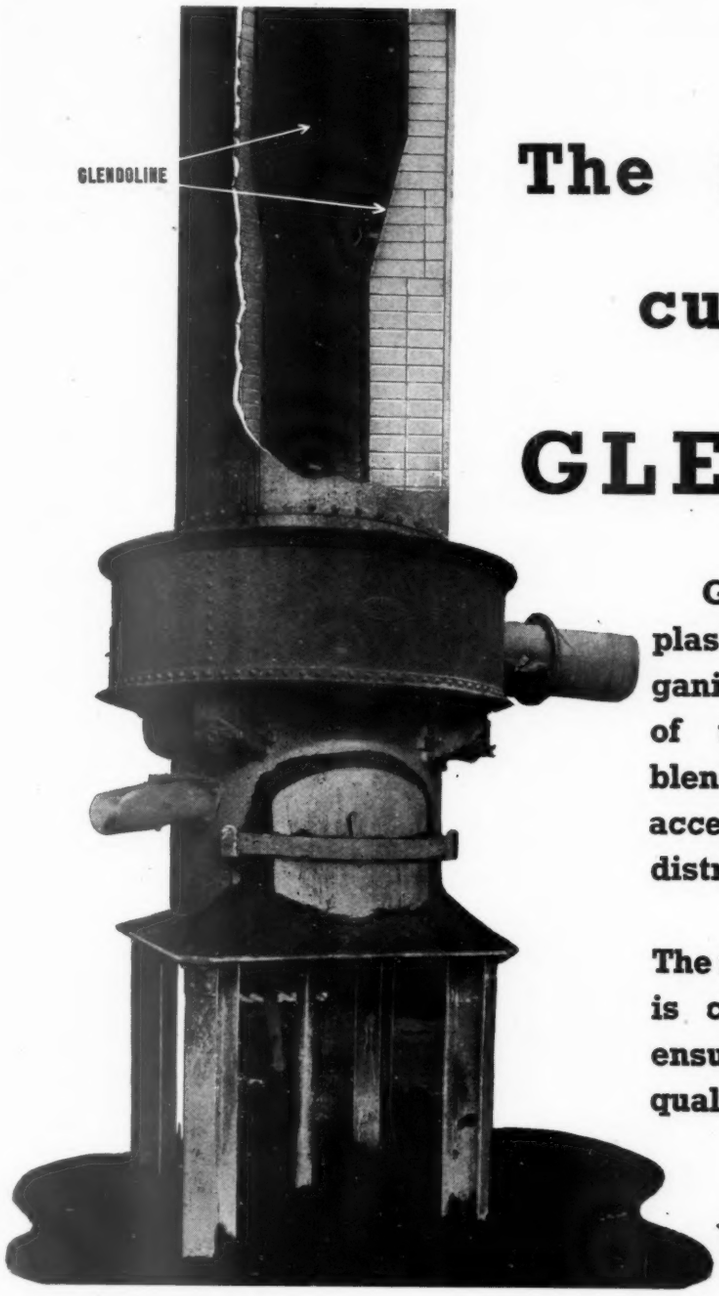

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Raw Material Markets

The first month of the year has closed on a disappointingly quiet note so far as the iron and steel markets are concerned. The lower quotations brought into operation at the end of 1938 did not have the expected result of acting as an inducement to consumers to buy on a large scale; so far this year business has continued largely on a hand-to-mouth basis. It is, however, confidently expected that there will shortly be an improvement in the home markets. The rearmament programme is responsible for the consumption of large tonnages of iron and steel, and many consumers are known to have brought down their stocks to a low level.

Pig-Iron

MIDDLESBROUGH.—Current trade on both home and export account is still quiet. The lack of orders from oversea consumers is not really surprising, on account of the lower quotations ruling on the Continent, but it had been hoped that by now there would have been a broadening of inquiry from local users. Meanwhile, output is low and of the 21 blast furnaces operating in this area, not one of them is on full-time production of foundry iron. For delivery in the Middlesbrough and Falkirk areas, No. 3 Cleveland G.M.B. foundry iron is quoted at 99s., No. 1 102s., and No. 4 foundry and No. 4 forge 98s.

Makers of hematite are restricting the production, so that output is approximately equal to the demand. In many cases, producers are in possession of fairly substantial stocks. The outlook, while not particularly encouraging, seems to indicate that there will be a better call for supplies in the near future. Export trade is negligible, and it cannot be said that there is the slightest possibility of an increase in the demand from this source while the margin between home and Continental quotations is so great. East Coast mixed numbers for the home trade are quoted at 120s., delivered Middlesbrough, 125s. 6d. in Sheffield and 131s. in the Midlands.

LANCASHIRE.—There has been a further slight improvement in the call for contract deliveries of pig-iron, but new contracts are not being negotiated very freely, and any new orders are generally for small parcels for early deliveries. The outlook for trade depends to a large extent on the light-castings makers, who, at the moment, are poorly employed. Offers of Derbyshire and Staffordshire brands of No. 3 foundry iron are on the basis of 104s., with Northamptonshire No. 3 at 102s. 6d., and Derbyshire forge iron at from 101s. to 103s., according to the class of consumer. Although, on the whole, the hematite market is still quiet, a few replacement orders are coming to hand.

MIDLANDS.—High-phosphorus pig-iron is still in quiet demand, and the call for contract deliveries is only of a spasmodic character. Since the reduced prices came into operation there has been more activity in the way of small orders, but consumers are disinclined to enter into long-term contracts. For delivery to Birmingham and Black Country stations, Derbyshire No. 3 foundry iron is quoted at 101s. per ton, with Northamptonshire No. 3 at 98s. 6d., both less 5s. rebate. An additional 11d. per ton is charged if delivery into works is required. Heavy engineering and jobbing foundries continue to take up heavy tonnages of low-phosphorus iron, while there is also quite a good demand for this type of iron from foundries connected with the machine-tool trade. Prices are not controlled, and for heavy orders makers are prepared to make concessions. The quotation varies from £5 5s. to £6 per ton, delivered the Midlands. Low-phosphorus iron from Scotland is quoted around £6 5s., owing to the transport charges involved. There is a much brighter tone in the hematite section of the market; consumers are not in a position to enter into long-term contracts, but deliveries under existing commitments are keeping the producers fairly busy. It is thought in many quarters that by the end of March some users will have need to re-enter the market on a good scale. East Coast No. 3 is quoted at 131s. and West Coast mixed numbers 132s.

SCOTLAND.—The pig-iron market here is quiet, and there is not much business passing. There seems to be a feeling of uncertainty about which is interfering with business and preventing people from taking anything but a short view. Stocks are mounting at the makers' yards, but there is so far no further diminution in the production. There is no change in the official minimum prices, which are 108s. for No. 1 foundry and 105s. 6d. for No. 3, f.o.r. furnaces. Short time is still prevalent in the light-castings trade, and makers have stocks as well as balances of contracts to take up. The recent cheap seller of Continental foundry iron seems to have disappeared, as the lowest figure now quoted is 92s. at Falkirk. The steelmakers continue to be out of the market as far as new purchases of pig-iron are concerned. Quotations are: Mixed numbers of hematite, 120s. 6d.; basic, 92s. 6d., both less 5s. rebate, delivered steelworks.

Coke

Although the turnover in the foundry-coke market is quite satisfactory, there is rather less activity at the present time, as domestic requirements are not so insistent as they were a few weeks ago. Ironfounders are generally covered for supplies up to the end of March, but there has not been much business done for delivery after that time. For delivery to Birmingham and district, the minimum price for best Durham coke and Welsh coke is 50s. 6d. per ton. This quotation is operative over the first half of the year, so that consumers have the opportunity to cover their needs well ahead. Supplies, however, are adequate, and there is consequently little necessity for users to buy so far forward.

Steel

Structural steel is moving away in slightly better tonnages, but orders are still on the dull side. Government orders are resulting in rather more business becoming available, and it is hoped that the rearmament programme will have still more requirements in this section, which is extremely badly situated so far as civil work is concerned. The demand for galvanised sheets for A.R.P. work continues to expand, and here, again, the business from the Government Departments comes as a welcome relief. Other sheets, too, have been in better request of late. Re-rollers of bars and strip are more favourably placed for work than they were a short time ago, and full time is being made in some instances. The tube trade, being more active, has recently been in the market for considerable tonnages of strip. An expanding business is being done in bright-drawn steel, and this section, too, is now looking forward to brighter trading.

Scrap

Increased production at several steelworks has already been reflected in the iron and steel scrap trade, but business, generally, remains dull and inactive. Contract deliveries are being taken up more freely, but the absence of new business is very much felt. However, a few small tonnages have recently changed hands, prompt delivery being stipulated. Foundries are not taking up scrap on the scale that might be expected at this time of the year, but here, again, the outlook has rather improved and specifications have been slightly better of late.

Metals

Political tension has continued to depress the non-ferrous metal markets, and easy conditions have prevailed. The eagerly awaited speech by Herr Hitler was both satisfactory and disappointing—satisfactory in so far as he expressed the opinion that "there will be a long period of peace," but disappointing in view of the fact that the international situation has not materially improved as a result of the German Führer's words. While so much doubt exists as to the manner in which the Reich Government will pursue its policy of "rectifying the Versailles Treaty," trade cannot hope to settle down to normal.

Copper.—Consumers continue to show little interest in entering into long-term contracts and business remains quiet. The tone of the market, of course, fluctuates according to current political feeling, which at the moment is not at all reassuring. It is reported from New York that consumption of copper by United States manufacturers during December was 33,187 short tons, against 52,708 tons in November.

Metal Exchange quotations were as follow:—

Cash.—Thursday, £42 to £42 2s. 6d.; Friday, £41 17s. 6d. to £41 18s. 9d.; Monday, £42 6s. 3d. to £42 7s. 6d.; Tuesday, £42 17s. 6d. to £43; Wednesday, £42 16s. 3d. to £42 17s. 6d.

Three Months.—Thursday, £42 6s. 3d. to £42 7s. 6d.; Friday, £42 2s. 6d. to £42 3s. 9d.; Monday, £42 12s. 6d. to £42 13s. 9d.; Tuesday, £43 5s. to £43 6s. 3d.; Wednesday, £43 2s. 6d. to £43 3s. 9d.

Tin.—The first backwardation in tin since February, 1937, occurred on Monday, when the price of cash tin improved by nearly £1, establishing a premium of 17s. 6d. over the forward position. During the past week there have been violent fluctuations in quotations, which have been all against the policy of the International Tin Control scheme, which has endeavoured to stabilise prices. It is generally thought, however, that speculators have been eliminated to a large extent.

The January issue of the "Statistical Bulletin" of the International Tin Research and Development Council states that although figures for the whole year just ended are available for a few countries only, it is possible to form already an opinion of the tin industry in 1938. The international quota of tin production averaged 53⅓ per cent. during the year, which is just half of that in 1937. Considering that this percentage is inclusive of the buffer stock quota, it is clear that the year 1938 was a far less favourable one to the tin industry than 1937. World production in 1938 is estimated at 148,000 tons, against 208,300 tons in 1937. The decrease is accounted for by the signatory countries, which produced 119,000, against 179,740 tons. World apparent tin consumption in 1938 is estimated at 152,000 (198,700 in 1937) tons, being a decrease of 24 per cent.

Official quotations were as follow:—

Cash.—Thursday, £208 15s. to £209; Friday, £211 15s. to £212; Monday, £213 10s. to £214; Tuesday, £216 5s. to £216 10s.; Wednesday, £216 to £216 5s.

Three Months.—Thursday, £209 5s. to £209 10s.; Friday, £211 10s. to £212; Monday, £212 10s. to £212 15s.; Tuesday, £215 5s. to £215 7s. 6d.; Wednesday, £214 15s. to £215.

Spelter.—At long last progress appears to have been made in regard to the application for a higher import duty on zinc. It is believed that minor details only remain to be settled. The spelter market has been quite steady of late, despite the prevailing uncertainty, but trade, on the whole, is not too satisfactory.

Daily market prices:—

Ordinary.—Thursday, £13 7s. 6d; Friday, £13 11s. 3d.; Monday, £13 13s. 9d.; Tuesday, £13 15s.; Wednesday, £13 12s. 6d.

Lead.—The Prime Minister's speech at Birmingham on Saturday did something to relieve the general unsettled conditions, but the market is still uncertain.

Day-to-day quotations:—

Soft Foreign (Prompt).—Thursday, £14 1s. 3d.; Friday, £14 2s. 6d.; Monday, £14 10s.; Tuesday, £14 13s. 9d.; Wednesday, £14 8s. 9d.

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